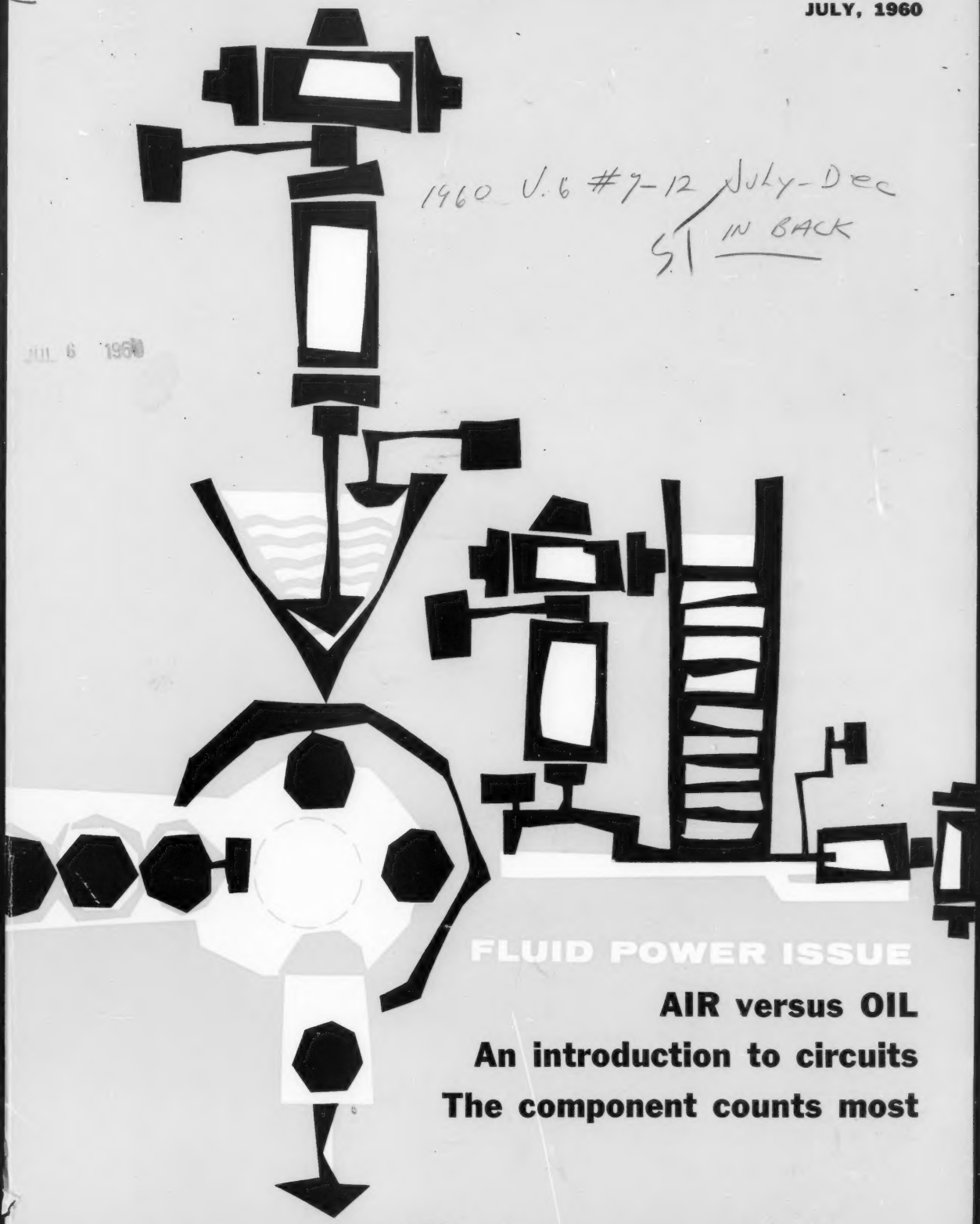
Design Engineering

JULY, 1960



FLUID POWER ISSUE

AIR versus OIL

An introduction to circuits

The component counts most

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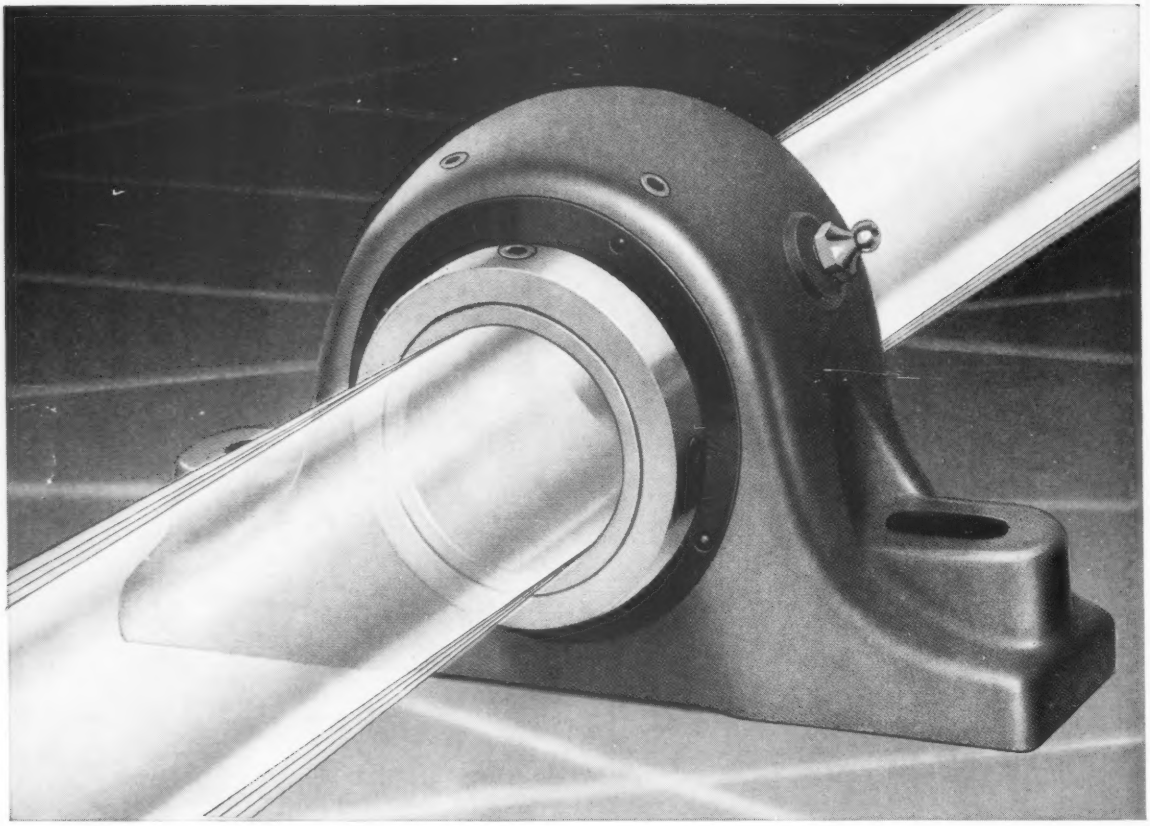
Free rolling . . . long lasting because it's *Self-Aligning*



Link-Belt roller bearings compensate for misalignment of shafts and supports

Link-Belt Series 400 roller bearings have won a reputation as "the designer's choice." These self-aligning, double-row roller bearings compensate for inaccuracies in machining and assembly of equipment while maintaining full load capacity throughout their long life. Their compactness promotes simplicity of machinery design—their easy mounting reduces installation costs.

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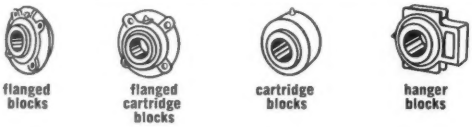

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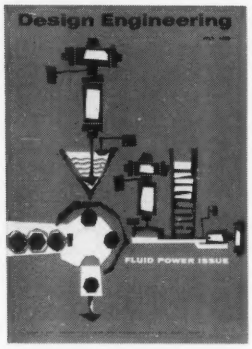

This month's cover

If you think our artist has taken liberties with this month's cover design — you're so right. However, he's been very conservative compared to some of the liberties taken by engineers when attempting a design incorporating fluid power, the theme for this issue.

Actually, artist Gerry Bern based his paper cutouts on a design for filling metal, plastic or paper containers with either liquid or dry materials, and then capping the package.

And, we are told, the thing actually works!

Contents—FLUID POWER ISSUE

Departments

Reader Service

Before reading further, turn to the back of the book and tear out a Reader Service Card. Circle the numbers as you go and mail the completed card to us—no postage is required. We will take care of your requests immediately.

Note the special Fluid Power Card this month. Check the items you are interested in and we will ask the suppliers to send the latest literature to you—all free of charge.

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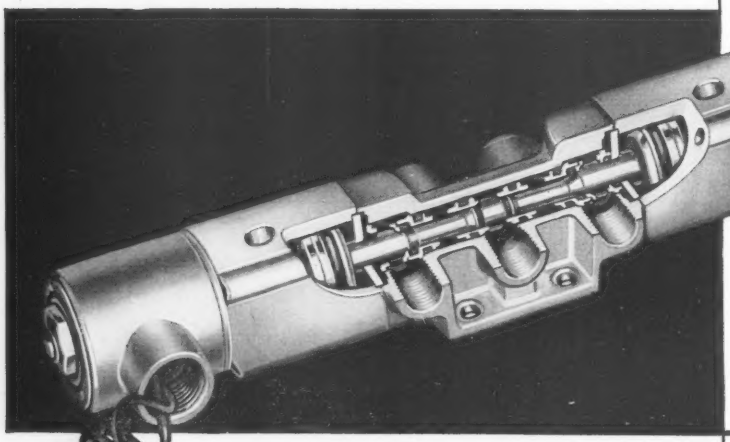

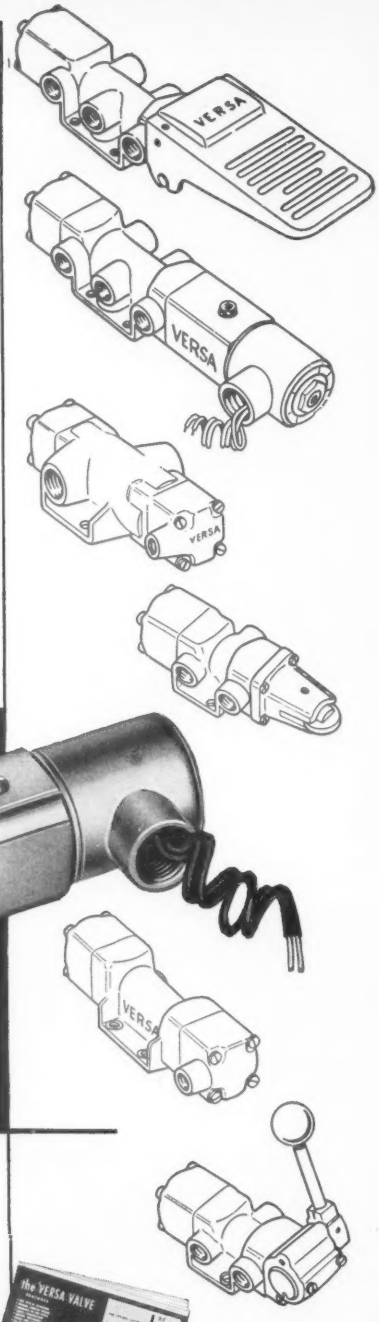

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Design Engineering

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The contributors

The monosyllabic man

This month's contributors all appear to have one thing in common. They are terribly modest. Or if it isn't modesty it's taciturnity.

For instance, here's a rough account of the conversation we had with L. Irwin Walle, who contributed the piece on An Introduction to Circuitry.

Us: "Tell us about yourself."

Walle: "Like what?"

Us: "Well, where were you born?"

Walle: "England."

Us: "And where were you raised?"

Walle: "Middle East mainly."

Us: "What did you do after you left school?"

Walle: "Army."

Us: "That would be the British Army?"

Walle: "And Canadian."

Us: "What did you do in the army?"

Walle: "Designed hydraulic recoil mechanisms for guns."

We tried to draw him out further, but he explained urgently that he was in sales now (had been for the past eight years) and was on the run. He ran.

The man who likes calculations

We had even less success with Trevelyn H. Beard, who contributed the piece on the mathematics of hydraulics. Again and again we tried to draw him out, but all he would talk about was his company (he is chief engineer of Fluid Power Ltd.)

"Well, Trevor," we said, "tell us about yourself" (though in fact we know all about him, as he is an old friend of this column).

"We manufacture," he said "the established line of Viceroy products, which consist of pneumatic and hydraulic . . ."

This time it was we who ran.

The man with the tools

Clifford P. Farr, who referees the controversy over oil and air, was just as reticent as his fellow authors, but we gathered after considerable research that tools are his life. The word "tool" necessarily appears eight times in the following brief biography.

Cliff is past chairman of the American Society of Tool Engineers. A graduate engineer with 20 years' experience in tool engineering and machine tools, he is manager of tooling facilities at Massey-Ferguson Ltd. Before that he was with Modern Tools Ltd., where he developed special purpose machine tools. During the war he was chief tool engineer of the S. F. Bowser Instrument Division, where he tooled up submarine detectors, etc.

The tight-lipped valve men

Donald B. Guy and Arthur Liley, both of Bellows-Valvair Ltd., Toronto, were even more reserved than the preceding three. Vice-president and general manager, Don wrote Do You Know Your Cylinders and Valves? All we got out of him was that he was born in Boston, graduated from Northeastern Universities, Boston, with a B.Sc. degree, and also attended Pennsylvania and Yale.

Arthur, the sales manager, wrote It's the Component that Counts. Tight-lipped, he told us that he was born in London, Ont., and went to the University of Toronto.

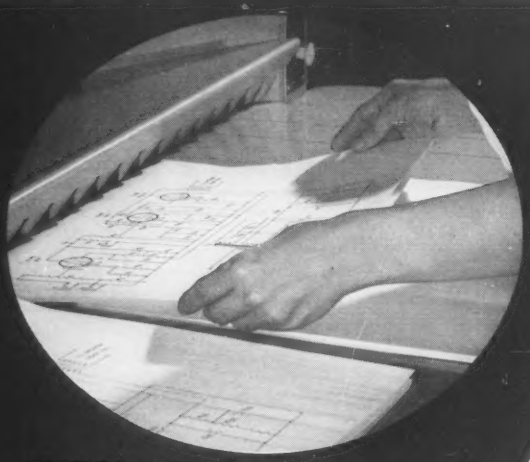
The least reserved man

Less reserved than any of the others, though still not exactly garrulous is Peter J. Herzl, author of the article on air and oil in machine control. Born in Vienna, he came to Canada in 1939 at the tender age of 14 and later went to McGill, where he completed a mechanical engineering course in 1947. He served a spell at Northern Electric on special purpose machines and at RCA Victor on the planning of automation techniques, then in 1956 joined Sperry Gyroscope. The job has taken him traveling to Europe and the U. S.

He has a lovely wife, a daughter of two years and a baby son. He also has two other interests, music and photography, but in recent years there's been little time for these.

Walle Beard Farr Herzl Guy

NEED PROOF?



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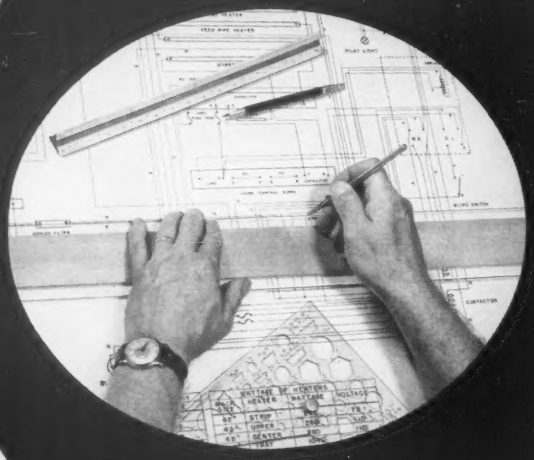

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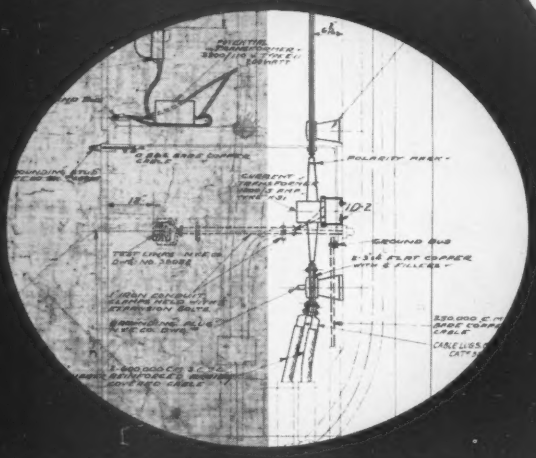

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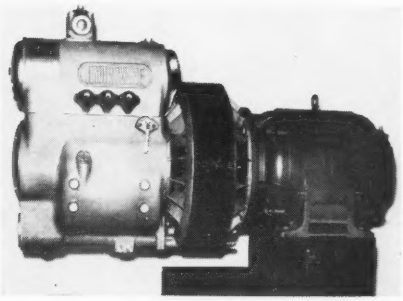
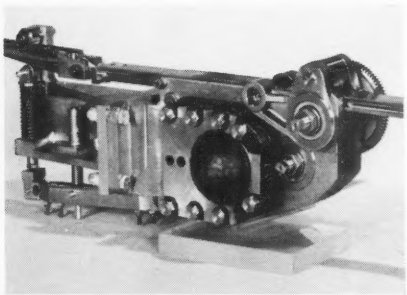
Reports — A world roundup of engineering and design interest

Several small units better than one big one, they say



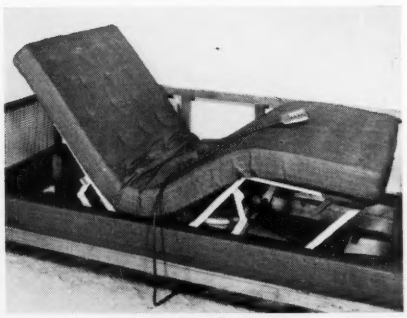
There's a trend in industry toward decentralizing the compressed air supply. Instead of a large central unit, more and more major Canadian manufacturers are installing individual compressor units to departments or operations. Advantages: you avoid line load variation; no danger of a central shutdown; each department's supply can be engineered to its own requirements; it's cheaper and safer than piping air through the plant; the individual units can be switched off in slack periods. The 15 hp unit illustrated is typical of compressors used to decentralize air supply. It has a displacement of 75 cfm at 100 psi and free air delivery at 68 cfm at the same pressure.

In a jet, pneumatics have the edge on hydraulics



These days it takes only a flick of a switch to activate almost any piece of auxiliary equipment of a jet plane traveling at supersonic speed. But to achieve such precision requires unerring performance by tiny motors made of materials which must hold their strength and stability even at temperatures of 1,500 degrees Fahr. Hydraulic actuation systems, which are common on slower-moving aircraft, run into frequent trouble when friction temperatures pass the 500 degree mark. For jet planes, therefore, designers are turning to pneumatic systems, like this nutating disc air motor actuator. The housing and crankshaft and most of the structural parts are made of S-816, a cobalt-base alloy available in cast and wrought form.

Push-button bed is hydraulically operated

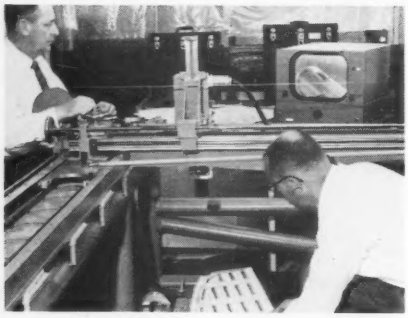


Talking about hydraulics, a manufacturer of hydraulically operated convertible tops for the automobile industry has brought out a hydraulically operated and electrically controlled contour bed. At a flick of a switch the bed shapes itself into a variety of positions for reading, writing, eating, TV viewing or just sleeping. When not contoured, the bed is horizontal; at full contour height the user's head is elevated at a 70 degree angle and his feet are five inches above the hips. The unit uses a single hydraulic cylinder powered by a one-third horsepower electric motor to raise both ends simultaneously. A deluxe model has four switches for independent movement of the two ends. Parts are permanently sealed to prevent leakage and no lubrication is necessary.

Modified gas turbine burner gives improved results

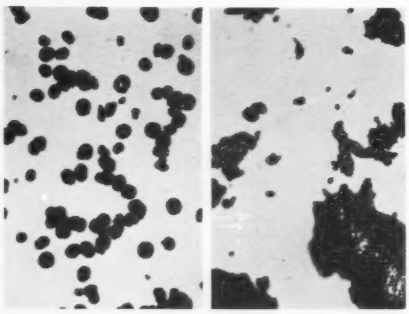
Design improvements in a small gas turbine burner have increased its performance and efficiency. They have also enhanced the turbine's facility for utilizing various types of fuels, ranging from kerosene to jet fuels. And finally they have solved a cracking problem around the air inlets and reduced the number of "cold spots" (areas below 1,100 degrees Fahr.) which may generate harmful carbon deposits during combustion. What are these design improvements? The Boeing Airplane Company isn't saying any more than that the improvements were on the burner dome and liner and that the air inlets were modified. More than 100 burner dome inserts and liners were developed and tested; here an engineer displays the final design.

Closed circuit TV cuts inspection time 40%



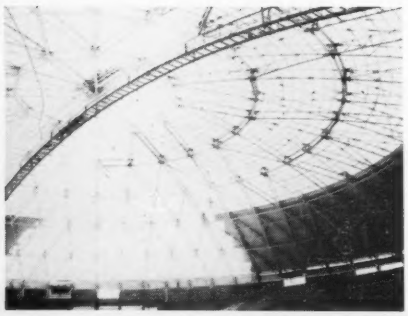
New uses for closed circuit TV keep cropping up. Now Convair is using it for precision inspection of aircraft parts. The system reduces inspection time 40% to 70%. Under the old system, sections had to be fixed to a surface plate and measured with a height gage; a second measurement along another axis required a new set-up of the section, a procedure that might take several hours. To lick the time problem, Convair engineers designed a universal inspection machine with an open interior. Across the top is a carriage which can be moved from one end of the frame to the other. The carriage holds the TV camera, which can be moved to any position over the table. The camera can move in both axis, so the engineer can take his readings in both directions—without moving the test part.

Polyethylene steps out in new form



Latest news on the polyethylene front is that the resin is now available in North America in finely divided (powdered) form. This makes many new applications possible, besides broadening the existing ones. One of the largest potential markets will be in the textile field, where it's used to coat fabrics or to bond a fabric to another piece of cloth for stiffening. Other possibilities are metal coating (to protect against corrosion), paper coating (to make synthetic glassine), wire and glass coating. This new polyethylene, known as Microthene, can be applied in powder form or in water or alcohol dispersions or pastes. Picture shows Microthene in its two basic forms: left, small particle size (smaller than 200 screen mesh) and with a smooth surface; right, larger particle size (50 to 200 screen mesh) and an irregular shape and surface.

No columns in 270-ft. span of arena roof



Though it has a span of 270 feet, there are no interior columns in this arena roof. They were omitted to provide facilities for ice skating, theatrical shows, athletic contests, concerts, etc. Skewed structural steel framing was chosen for economy and the results bore out the designer's judgment: roofing an area of 57,400 sq. ft. without interior columns required steel weighing only 12.3 pounds per square foot. An added dividend from the diamond shaped pattern of the exposed steel framing is that the trussed ribs give an interesting lace-like effect. The erection sequence was an innovation; it was found to be less expensive to erect a complete ring at a time, starting at the tension ring and working upward and inward, than to erect one complete pie-shaped section at a time. The arena is at Green Bay, Wis.

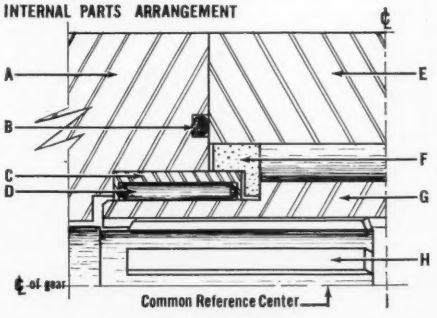
COMMERCIAL Announces...

A Remarkable New Fluid Power Pump

COMMERCIAL presents the new, Series 15H fluid power pump—a logical extension of its Series 36H line which has received such outstanding acceptance. This small powerhouse possesses all the proven basic features of the larger COMMERCIAL fixed displacement gear pump but is designed for those applications where flow requirements are less. The Series 15H is made in ½", ¾", 1", 1¼", 1½", 1¾" and 2" gear widths and covers a delivery range from 3 to 15 gpm at 1200 rpm. It is recommended for continuous duty operation at pressures up to 2000 psi—at speeds up to 2400 rpm. Volumetric and mechanical efficiency rate over 90%. 15H pumps are available for flange or pad mountings of many styles and can be furnished with ports to accept tapered thread, straight thread or SAE split flange fittings.

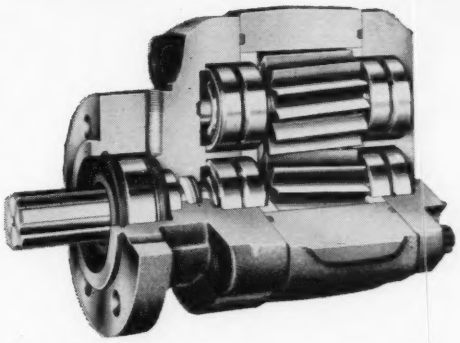
High performance for keeps

Perfect alignment is "built in" these pumps because of their unique basic construction which establishes the machining of all internal parts from one common reference, the gear center line. (See drawing.)



A-bearing carrier
B-"O"ring seal
C-bearing outer race
D-bearing roller
E-gear housing
F-floating thrust plate
G-gear
H-drive shaft spline

As shown, gear bearings also act as dowels—outmoded dowel pins are eliminated.



Matched helical gears having mirror finish ground on all surfaces contribute to high volumetric efficiency and quiet operation. Thus, complete sealing is maintained—tooth to tooth and tooth to gear housing. Ruggedness, greater load capacity and dampening of unbalanced internal loading are assured by using integral gear hubs to serve as journals for the pump's oversize gear bearings. In order to meet its own exacting standards, COMMERCIAL must, and does, produce its own gears.

A dynamic seal is maintained between gear faces and special bronze alloy gear thrust plates. The entire thrust plate "closes in" against the gear face because of pressure pocketed behind the plate, thus compensating for any wear on its gear contact surface. Because the sealing area is confined to a small portion of the contact surface, the amount of friction has no appreciable effect on pump mechanical efficiency.

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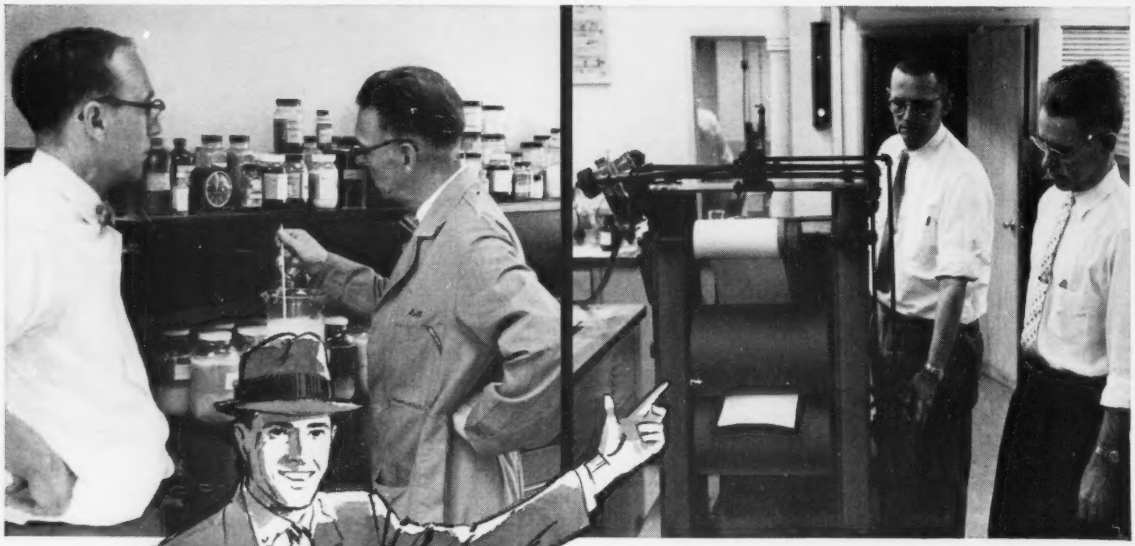
RESEARCH DEVELOPMENT

Practically all of the advances in surface treatments for metals have come from the big, ingenious Parker research staff. This consultation is on a new treatment for hot dip galvanized.

An improved Parker product for use in laminating plastic to metal undergoes checks and tests in the development lab. Parker products are carried from test tube to production line by Development.



Here's why the are Parker's conversion

Start with the experience and knowledge of the field which has built the Parker line. Our restless search for new ways and better ways to protect metals and increase finish durability has been continuous for almost fifty years, and has produced practically every major advance in the science.

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FIELD SERVICE

The Parker field service representative, stationed near you, averages 14¾ years of experience in the conversion coating field.

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A $\$\frac{1}{4}$-million investment on your behalf is the production line Customer Service Lab. It's organized as an extension of your research and development program. Here we take your materials and treat them on a production line basis to work out the proper processing procedure, set time cycles, solve a cleaning problem, prepare material for experimental manufacture in your plant. All without charge.

For the low cost of the Parker chemical alone, you get this complete package of service and satisfaction. *It's the biggest bargain in the business.*

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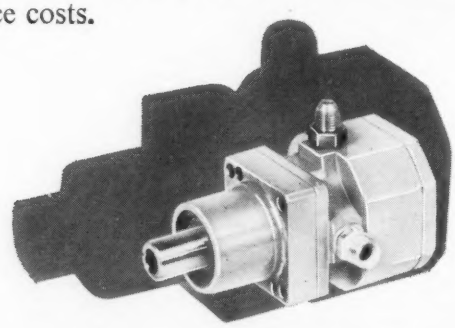

Size of Lucas-Rotax Type IA4 Pump is shown in relation to size of competitive unit of comparable rating.

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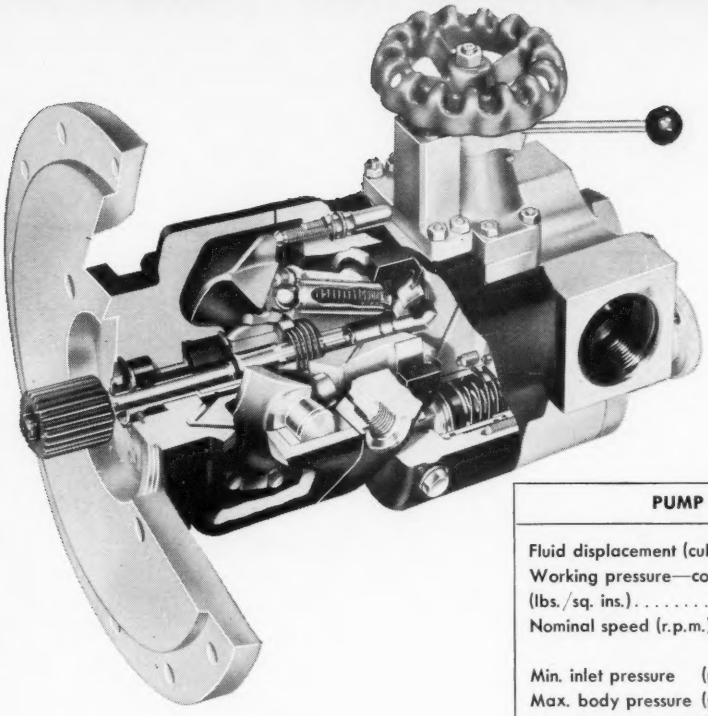

Lucas-Rotax Type IA 38-9 is a nine piston pump, variable volume, pressure compensated, designed for application on Ground Support Equipment.

PUMP DETAIL	BASIC UNIT
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Working pressure—continuous	5000 @ 15 g.p.m.
(lbs./sq. ins.)	3000 @ 30 g.p.m.
Nominal speed (r.p.m.) peak	4000
—continuous	3750
Min. inlet pressure (p.s.i.g.)	10
Max. body pressure (p.s.i.g.)	200
Compensation speed (seconds)	.045
Operating Temperature (°F)	250 to —40
Weight (less A.N.D. flange)	37 lbs.
Direction of rotation (viewed on shaft)	C/Clockwise

Models are available from domestic stock in capacities from 1.5 g.p.m. to 108 g.p.m., capable of pressures up to 5,000 p.s.i. Write for technical literature, or contact the agent or office nearest you for further information.

ROTAX
LIMITED

LUCAS
ROTAX

BUY CANADIAN

MONTREAL • 5595 ROYAL MOUNT AVENUE • RI. 8-7737
VANCOUVER • INTERNATIONAL AIRPORT • CR. 8-5104

6003-R

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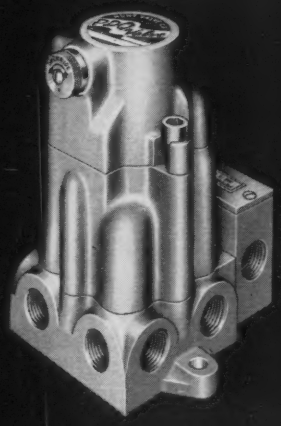
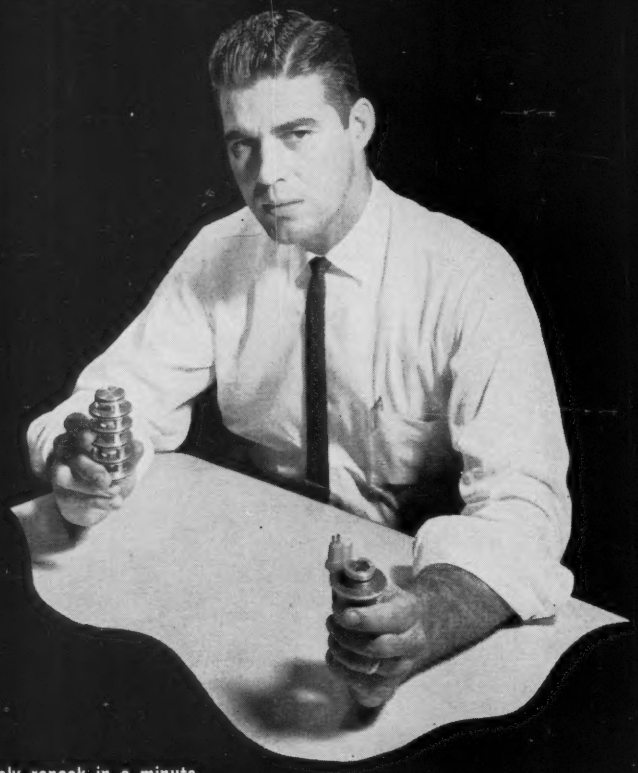
After years....if you do have to "repack"

JUST REPLACE 2 SELF-CONTAINED UNITS

IF IT'S A HUNT PDQ AIR VALVE





You want an air control valve that **one man can completely repack in a minute** on the bench or on the line.

We have that valve for you.

To repack the HUNT PDQ you just slide two simple self-contained units into place. One . . . the poppet spindle-sleeve assembly. Two . . . the plug-in solenoid pilot assembly. That's all!

You want a minimum inventory of spare parts. With the HUNT PDQ valve you stock **only two spare units** . . . not several dozen parts.

One man . . . any man . . . can completely repack the PDQ (including the solenoid pilot section) in less time than it takes you to read this ad. And your line is back in operation again.

This is the valve you want and need. Write today for the full story on the PDQ.

A. V. Ney

A. V. Ney, Sales Manager

HUNT VALVE COMPANY · SALEM, OHIO, U. S. A.

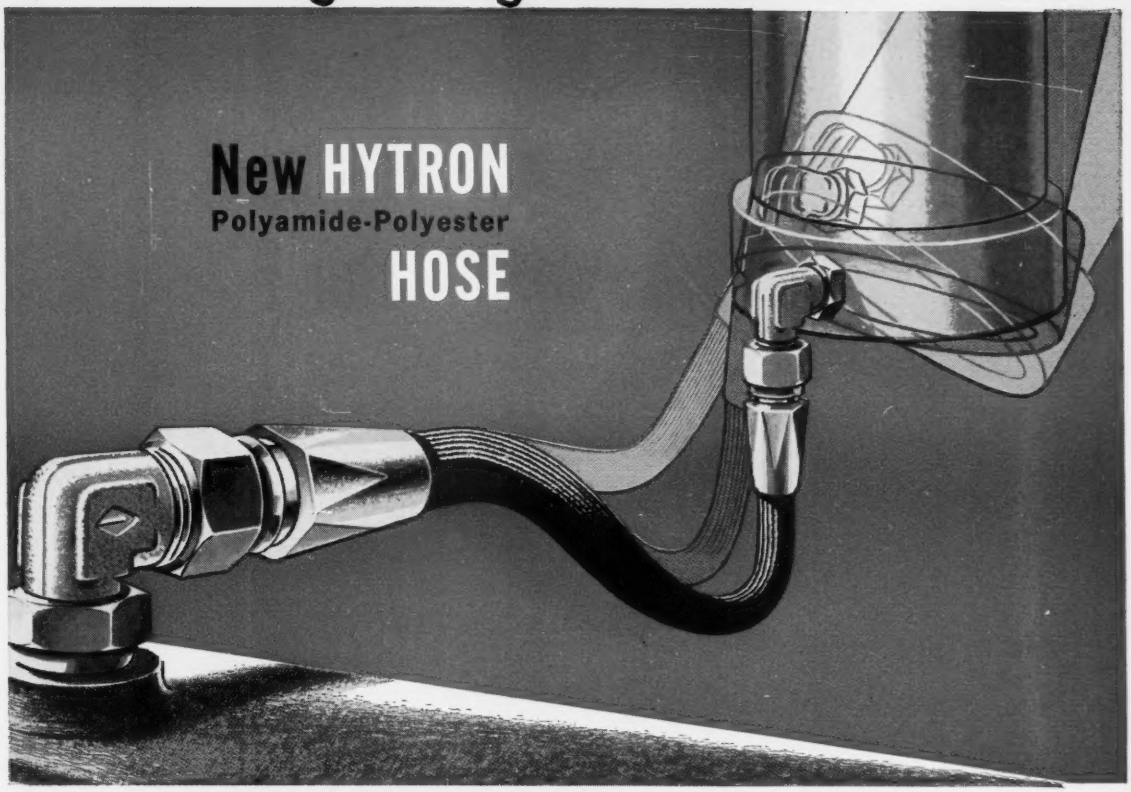
- ☑ Accessibility
- ☑ Simplicity
- ☐ Speed and Capacity
- ☐ Price and Quality

The Hunt PDQ valve tops them all in every class.

Next month . . .
the SPEED and CAPACITY story.

HUNT HVC ***Quick-As-Wink*** AIR & HYDRAULIC CONTROL VALVES

IMPERIAL
Engineering and Data File



FAR GREATER FLEX-IMPULSE CAPACITY...

IMPROVED PRESSURE HOSE PERFORMANCE

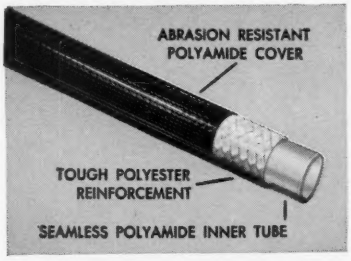
Imperial unveils a completely new concept in pressure hose — opening new opportunities in hydraulic and pneumatic circuitry design, bringing new economies and advantages to thousands of other hose applications.

Hytron was created to solve many of the problems encountered in using S.A.E. types 100R1 and 100R5 hose. It radically reduces hose size and weight, offering smaller O.D. for equivalent pressure capacity and I.D.

Flex-Impulse Test Results

Hytron superiority under punishing flex-impulse conditions has been clearly demonstrated. Comparable 24" lengths of hose with couplings were subjected to cycles from 0 psi to 3500 psi at one-second intervals. Simultaneously they were flexed at 60 times per minute.

After 57.4 hours the S.A.E. 100R5 single wire braid rubber hose burst near a coupling. It took 415.5 hours — *over seven times as long* — before the Hytron hose failed.



Note that there is *no wire braid* in Hytron hose. This eliminates one of the major causes of fatigue failure. Hytron is 80% lighter in weight, and, unlike wire braid rubber hose, retains virtually all of its flexibility under pressure.

Imperial Hytron hose operates in a burst pressure range from 9000 to 12,000 psi, depending on size and temperature. It is recommended for continuous service with fluids from −40 to 225°F, and for intermittent service to 250°F. Hytron is unaffected by nonflammable hydraulic fluids up to 180°F and flammable fluids up to 225°F.

Hytron hose is available in exceptionally long lengths. Furnished as factory-made assemblies, or with easy-to-install reusable couplings. Hytron couplings are of a new design that greatly minimizes flow restriction, offering up to 157% greater flow capacity.

IT'S IN THE BOOK

A new engineering report on Hytron hose and couplings contains detailed test results and performance figures. Send for your copy of Form No. NEPR-500 today.

IMPERIAL BRASS MFG. CO.
(Canada) Limited
18 Hook Avenue, Toronto, Ontario

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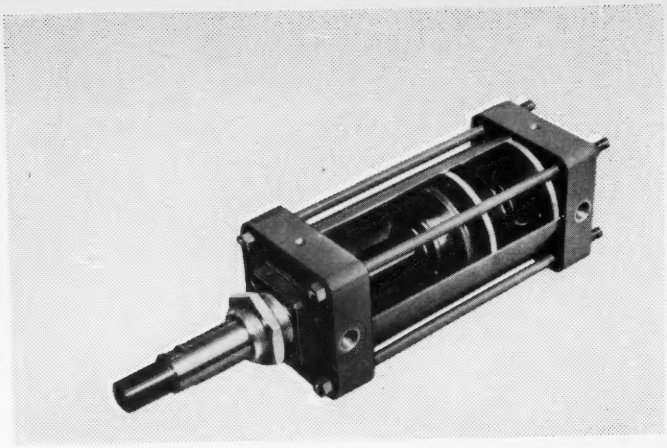
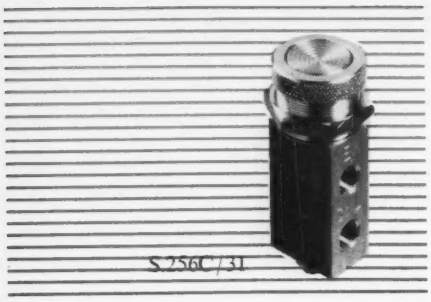
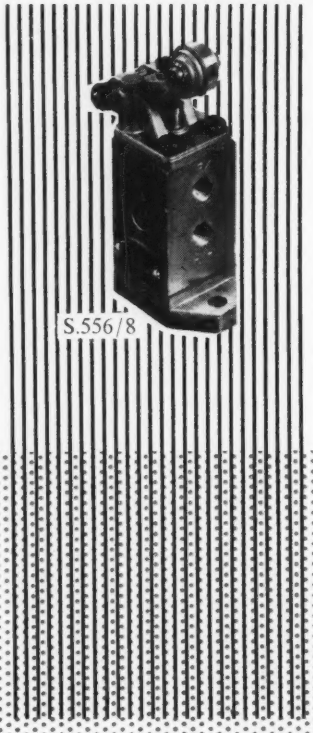
Martonair

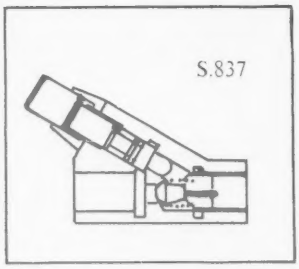


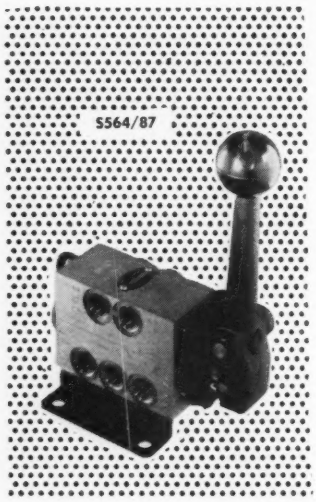


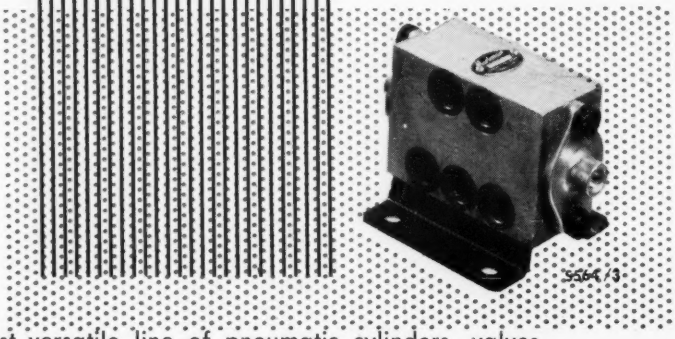
The *First* Name in pneumatics

Worldwide Stocks & Service









Martonair offers you a most versatile line of pneumatic cylinders, valves, and control devices, as well as engineering assistance with your application problems.

For new ideas, ask to be put on the circulation list for our publication "Applied Pneumatics".

MARTONAIR (CANADA) LIMITED

25 CARSON STREET, TORONTO

(Distributed by Cowper Company Limited, Lachine, P.Q. and John Spotton Company Limited, Toronto 14, Ontario)

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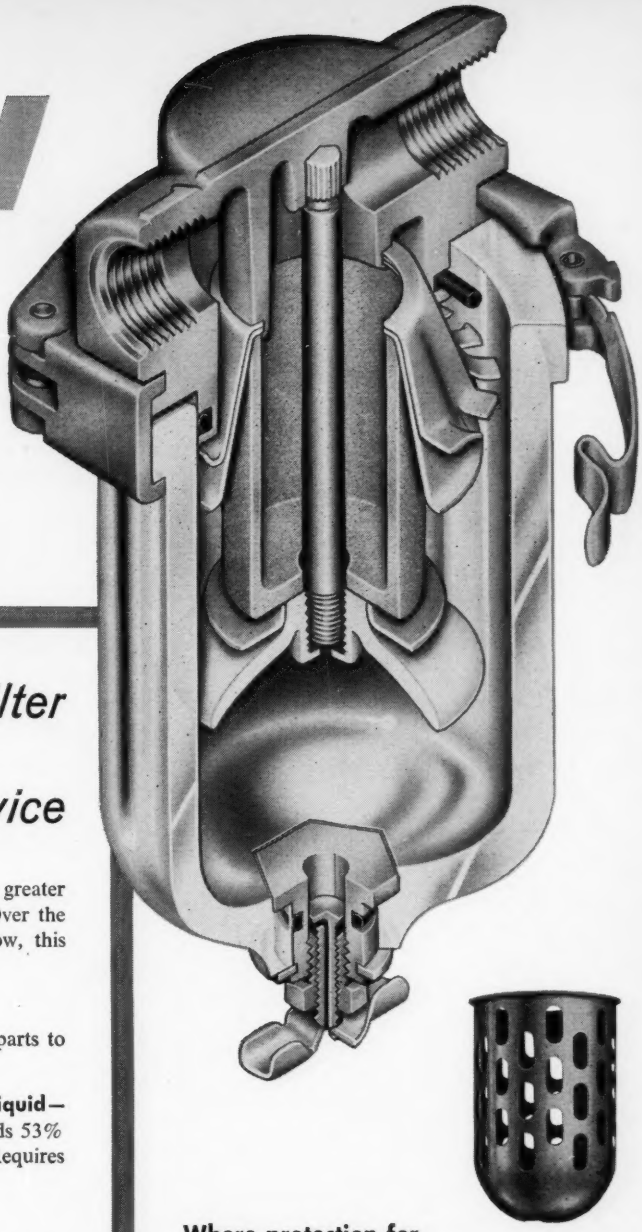
Announcing

NEW

Norgren

COMPRESSED AIR LINE FILTERS

for ¼", ⅜" and ½" pipe sizes



The most efficient filter you can buy...
the easiest to service

1 **100% liquid removal—**
Improved Norgren design provides a greater than ever liquid removal efficiency. Over the entire range of recommended air flow, this filter effectively traps all liquids.

2 **Easier and quicker to service—**
No tools needed and only 4 separate parts to handle.

3 **Larger bowl capacity for collected liquid—**
The "quiet zone" below the baffle holds 53% more collected air-line contaminants. Requires less frequent draining.

4 **New improved bowl—**
New, stronger transparent bowl has greatly improved resistance to fatigue failure.

PLUS *these important benefits:*

- **Highly effective removal of solids.**
- **Optional interchangeable filter elements—** 74, 64, 25 or 5 micron.
- **Reduced service time**—the simplest, easiest filter to disassemble and clean.

Where protection for transparent bowls is required,
a metal bowl guard, held in place by the clamp ring, is available.

CANADIAN REPRESENTATIVES:
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Galbraith & Sulley, Ltd., Vancouver 9
John Spotton Co., Ltd., Toronto 14
Write for Brochure NA-1.

C. A. NORGREN CO.

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MADE BY
DU PONT
IN CANADA
FROM CANADIAN MATERIALS

ZYTEL NYLON

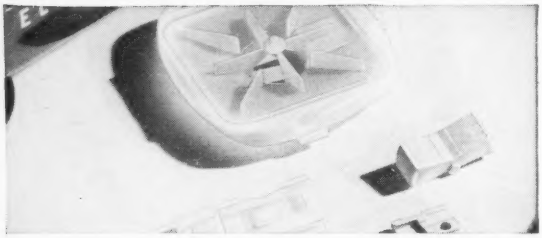
now costs less from domestic stocks

More and more mechanical parts are being moulded in Canada from Canadian-made "Zytel" nylon. Qualified moulders with years of experience in moulding this material can provide you with the best quotations and the best service available anywhere in the world. Consider these outstanding properties and call a Canadian moulder — he can help you to lower costs and improve performance — with "Zytel" nylon — Du Pont's outstanding engineering material.

- *Easily and economically moulded into finished parts.*
- *Models or prototypes easily machined from available stock shapes.*
- *Moving parts are quiet running.*
- *Nylon damps vibration and shock.*
- *Usually requires no lubrication.*
- *Low-friction.*
- *Little, if any, wear in contact with itself or metals.*
- *Lighter-weight than metals, stronger than other plastics.*
- *Can be moulded in color, dyed, painted or metalized.*
- *Can be cemented, spin-welded, solvent-welded, snap-fitted.*
- *Non-corrosive in most environments.*
- *Strong and tough, particularly in thin sections.*
- *Will take self-tapping screws.*
- *Electrical insulator.*

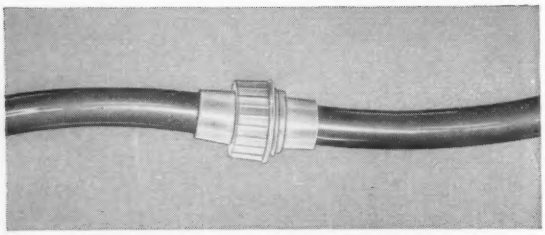
Du Pont's technical staff is available for discussions with designers and moulders concerning "ZYTEL" and other Du Pont high-quality plastics materials. Answers to your queries and free literature will be promptly provided on request.

THESE PARTS WERE DESIGNED AND MOULDED IN CANADA



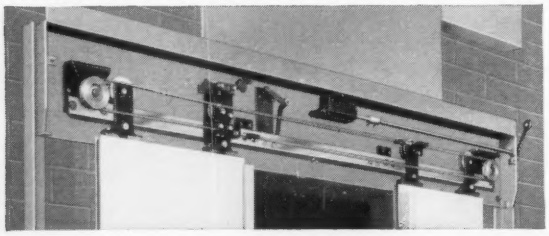
"ZYTEL" mouldings form key part of new Electrolux vacuum cleaner

Mouldings of "ZYTEL" were used for several important parts in the new "Elux-o-matic" vacuum cleaner. "ZYTEL" nylon parts were specified because the easy-moulding characteristics and high strength/weight ratio of "ZYTEL" could provide all the desired properties at the lowest cost.



Lower-priced hose couplings are moulded of "ZYTEL"

The high strength and durability of "ZYTEL" nylon is put to good use in this garden-hose coupling. It has become popular for its low pressure loss and ease of attaching and removing.



Silent elevator sliding door hangers of "ZYTEL"

Operating on sheaves of abrasion-resistant "ZYTEL" nylon resin revolving on permanently-lubricated "ZYTEL" ball-bearings, Turnbull "Quiet Glide" door hangers function with unmatched efficiency. Even when in continuous use, "ZYTEL" ensures reduction of track wear, long life, as well as reliable and extremely smooth performance.

DU PONT OF CANADA LIMITED, Plastics Division,

P.O. Box 660, Room A-4, Montreal, Quebec.

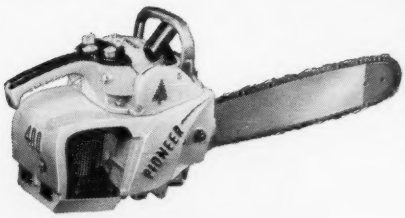
ZYTEL NYLON

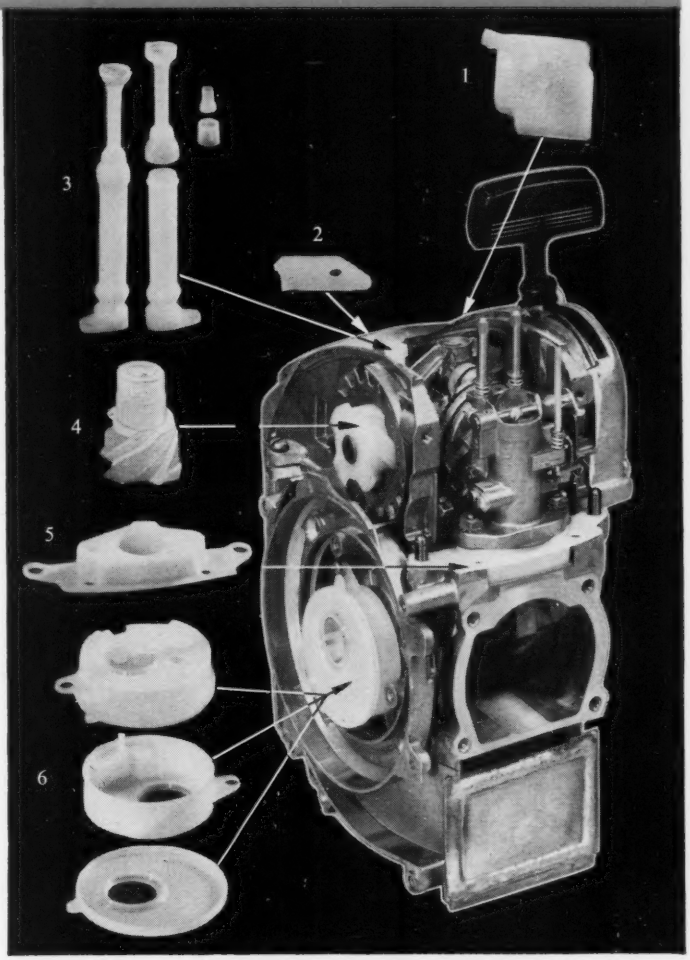
defies wear and tear

Pioneer Saws Ltd. new power saw features "ZYTEL" nylon components

ZYTEL* is an engineering material whose overall strength is not approached by any other common plastic. Pioneer Saws Limited, Peterborough, Ontario, have used "Zytel" to design parts in five vital areas of a new power chain saw. In addition, they use "Zytel" in several conventional applications, such as bushings and washers.

One of "ZYTEL" nylon's major contributions to this new type of saw is in the small pump which oils the saw blade. Formerly the pump was made of brass with a rubber washer. Temperature extremes and dirt caused it to seize, resulting in failure of the saw through lack of blade lubrication. Now, thanks to the resistance of "ZYTEL" to violent temperature changes, oil, and dirt, performance in tough bush service is trouble-free. Moreover, "Zytel" nylon, in thin sections, is flexible, eliminating the need for a separate washer. Yet, in thicker sections, "ZYTEL" is sufficiently rigid to permit an economical snap-fit assembly of the pump case and body.





Here are some other ways in which Pioneer Saws Limited has capitalized on "ZYTEL" nylon's unique qualities to introduce new value into their chain saw.

1. **Carburetor Cover** is resistant to gasoline, and is an example of simple cemented assembly of two "ZYTEL" nylon pieces.
2. **Terminal Block** made of "ZYTEL".
3. **Oil Pump** — moulding by Tilco Plastics Limited, Peterborough, Ontario.
4. **Large Spline** for starter utilizes "ZYTEL" nylon's strength and shock-absorption to replace brass, an expensive material, thus effecting important cost savings. The low friction coefficient of "ZYTEL" eliminates lubrication, thereby reducing clogging from dirt. Moulded by Tilco Plastics Ltd., Peterborough.
5. **Carburetor Insulating Block,** moulded of another Du Pont engineering plastic, "DELRIN" acetal resin.
6. **Breaker-Point Housing** keeps the points clean and uses "ZYTEL" nylon's electrical insulation qualities in this important functional part. The close tolerances possible with "ZYTEL" provide a total oil seal around the rotating crankshaft. Also moulded by Tilco Plastics Limited.

DU PONT CANADA

Better Things for Better Living ... *through Chemistry*

DU PONT PLASTICS

*Du Pont Trademark

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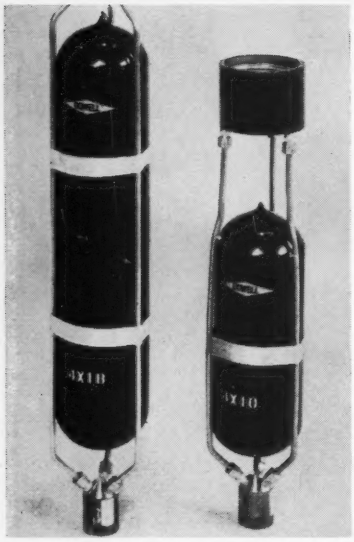
THIS IS GLASS

A BULLETIN OF PRACTICAL NEW IDEAS FROM CORNING



NEW WAY TO TICKLE A "TRICKLE" WELL

For some centuries now, great bangs around the globe have borne witness to man's sometimes happy faculty for putting to work the phenomenon we call "explosion."

Now we are finding ways to make use of *im*plosion. And glass is helping us.

Supposing your oil well starts to ooze instead of gush. You take one of the devices shown above and lower it into the well. Fill the hole with fluid and apply pressure. When the psi reach a set level, you get a squoosh and then a whoosh and then—with luck—a gush of oil.

The squoosh signals an implosion; the whoosh, a counteracting explosion in the fluids. Working together, the two forces develop pressure waves up to 20,000 psi, usually enough to fracture the surrounding strata and to stimulate the flow of any oil present in the formation.

The service using these capsules is called Rockshock;* it was developed and is offered by Dowell Division of The Dow Chemical Company. The capsules are made from PYREX® brand glass blanks which we supply. The capsules are evacuated to extremely low pressures.

We make the composition of the glass blanks and their wall thicknesses to exactly the right specifications so that the capsules will implode at specified pressures.

We make the glass so that it will *dice* when it implodes, disintegrating instantaneously to pieces small enough to pass through valves and pumps without damaging them.

At the same time, we make the glass sturdy enough so that you can handle the capsules used in Rockshock above ground with as much safety as glass bottles.

Dowell can tell you more about Rockshock. They are in Tulsa, Oklahoma. We can tell you more about the marvels of glass . . . say, in our Bulletin B-83, titled "Properties of Selected Commercial Glasses." We are in Corning, New York, and can be reached by coupon.

*Dowell Service Mark

STEAM GAUGE THAT WORKS LIKE A TRAFFIC LIGHT

When you see red, you're looking at live steam. When you see green, you're looking at water.

It's as simple as that with this new Multi-Port gauge from the Diamond Power Specialty Corporation.

Like so much that's simple, this takes a fairly complicated system of optics, for which we supply the glass.

Like so much that's complicated, this optical system takes advantage of a simple fact, namely, water and steam have different refractive indexes.

At the rear of the gauge a group of sealed-beam lamps (we probably made the glass for these, too!) throw light on two colored pieces of glass. One is red, the other is green. If the light then passes through steam, only the red portion gets through to the viewing port. Vice versa for water. If the water level falls half way up a port, you see both red and green with a sharp line of demarcation at exactly the right level.

You can see the gauge in the dark. Since light has the swiftest of all movement, there is absolutely no time lag when the steam level changes.

Aside from its optical properties, the glass we provide has to take the thermal shock of live steam, the corrosive environment of steam and water, and pressure up to 3000 psi.

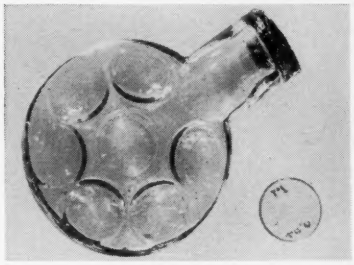
Actually, these are simple conditions for us to meet, as you'll discover, if you ever have occasion to put one of our glasses to work.

Bulletin IZ-1, "Designing with Glass for Industrial, Commercial, and Consumer Applications," can help you spot such occasions. The coupon will fetch you a copy.

WHY EYEGLASS LENSES DON'T COME IN BOTTLES ANY MORE

In 1912 this flask was a marvel of mass production. With just a few good puffs one of our glassblowers could produce blanks for a dozen or more eyeglass lenses.

Now look at the lens blank in the corner of the picture. It has the stamp of technology all over it. Code letters and numbers. Nicely finished edges. Each one like the other.



Now we have machines to stamp out lens blanks . . . even bifocal lens blanks . . . by the millions without a glassblower drawing breath.

A perfect example of our willingness to sacrifice the romance of handcrafting to the sheer economy and efficiency of machinecrafting whenever it will benefit our customers.

The only interest we expect you might have in all this is in this simple fact: we have *two* kinds of versatility to sell. The versatility of glass itself. The versatility of methods in manufacturing from glass.

We can cast giant mirrors and windows for radioactive cells, blow delicate bubbles for lab ware, press or roll great masses for items needed in large quantities in a hurry . . . in short, we can put to work practically every manufacturing method known to man to put your product in glass.

"This Is Glass" is a booklet that tells more about these methods and glass itself. It's in the coupon.

CORNING MEANS RESEARCH IN GLASS

CORNING GLASS WORKS, 39 Crystal St., Corning, N.Y.

☐ B-83; ☐ This Is Glass; ☐ IZ-1

Name..... Title.....

Company.....

Street.....

City..... Zone..... Prov.....

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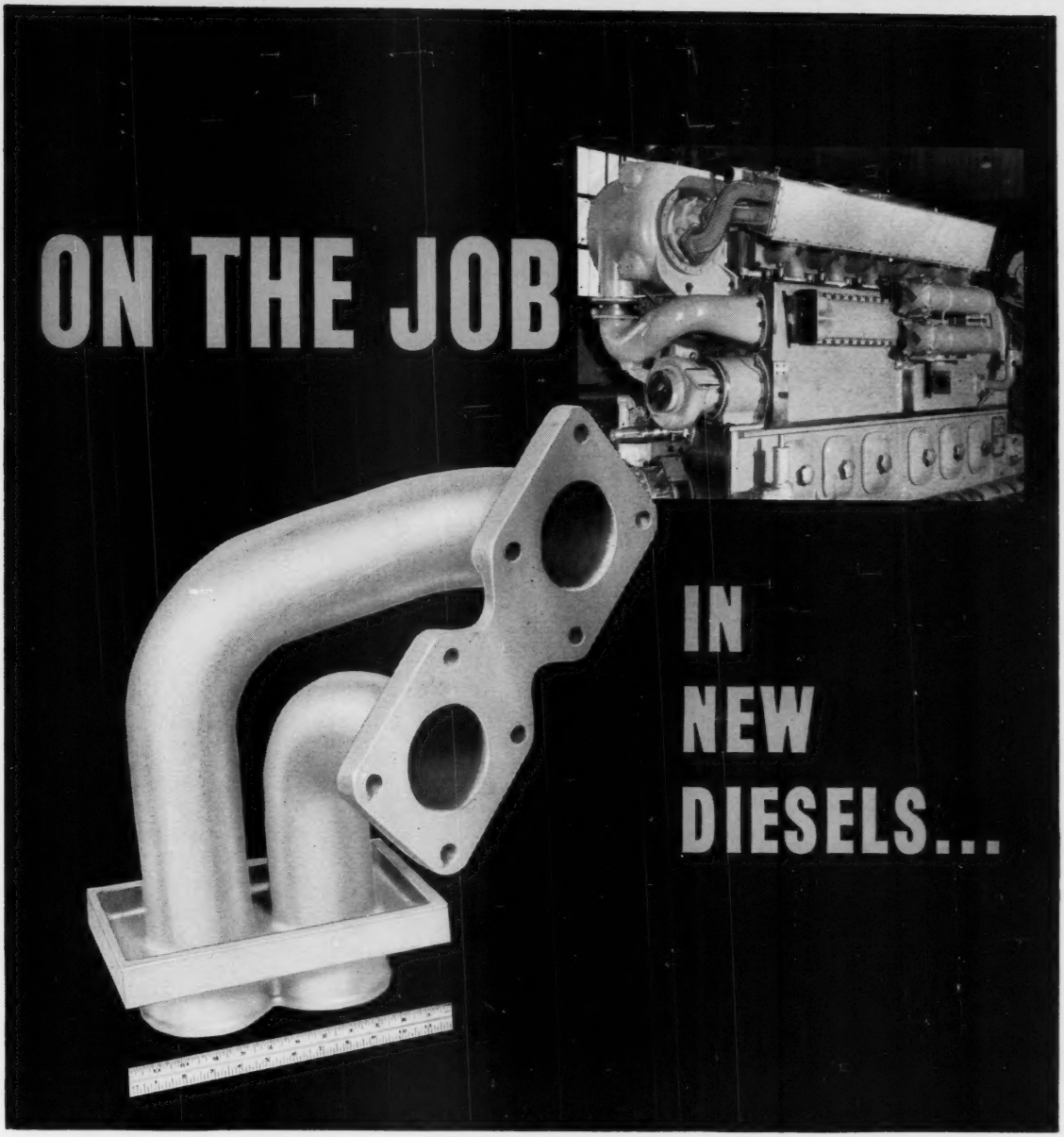

... ALLOY IRON CASTINGS, FOR LONGER WEAR, GREATER ECONOMY

This manifold, a Ni Resist Type 3 alloy iron casting produced in quantity by Canada Iron, is used in the exhaust system of diesel engines, built by Dominion Engineering Works, Limited.

You're sure of superior castings in the best and most suitable grade of metal when you work with Canada Iron. Our technology in the use of alloy irons . . . Ni-Hard, Ni-Resist, Ductile Ni-Resist, plus a wide range of Ductile (Nodular) and DOMITE* gray irons . . . assures you of quality castings for your specific requirements. Check with your Canada Iron man *now*.

Canada Iron CASTINGS
CANADA IRON FOUNDRIES, LIMITED

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EMpire 3-8801

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*Trade Mark Registered

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SPECIAL FASTENERS and COMPONENTS... *designed to reduce costs!*

Bending, flattening, threading, punching, shaving and other secondary operations are offered by Stelco as part of a comprehensive service in producing contoured parts for industry.

"Special" fasteners and components may be specifically designed for an individual requirement or may be a standard item adapted to do a special job.

On all such parts, Stelco's basic processes of cold heading or hot forming can offer important cost reductions. Material scrap is almost completely avoided. Production rates are fast. Often the savings in production, the economies in assembly, or the improved performance, will warrant redesigning as a Stelco "special" a part you are now using.

Consult Stelco's Fastener Engineers through the facilities of any Stelco Sales Office. It could result in important savings for you.

STELCO

THE STEEL COMPANY OF CANADA, LIMITED

Executive Offices: Hamilton and Montreal

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BUY CANADIAN

59193.B

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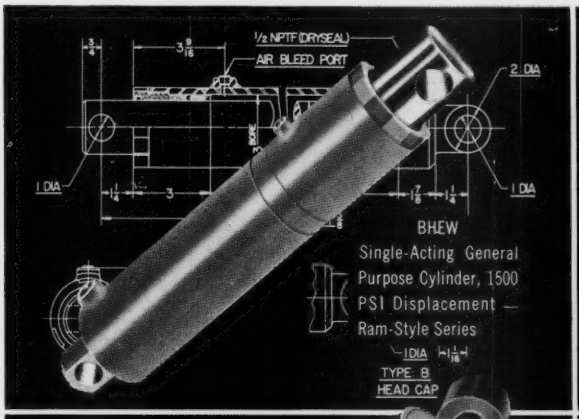
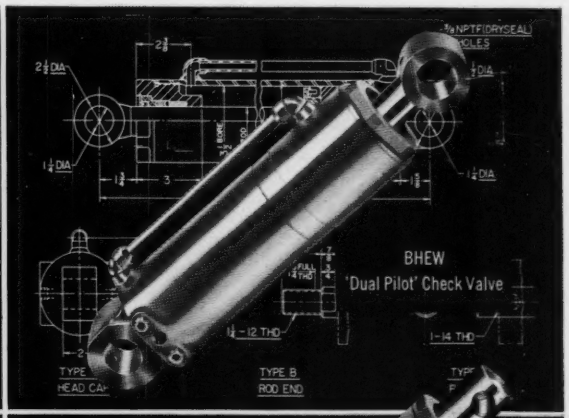
BHEW HYDRAULIC CYLINDERS

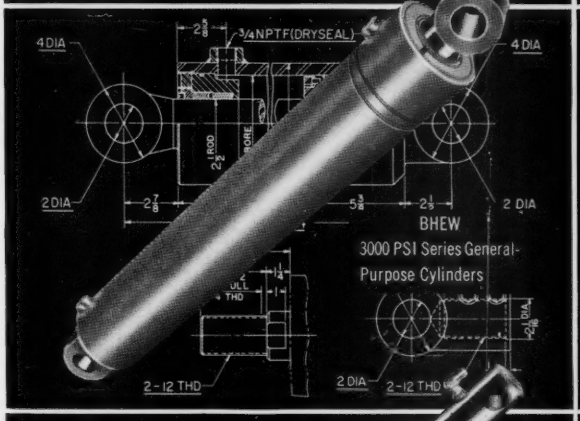
• BASIC DESIGNS • SPECIFIC ADAPTATIONS • SUPERIOR QUALITY • APPLICATION ENGINEERING



BHEW
Single-Acting General Purpose Cylinder, 1500 PSI Displacement — Ram-Style Series

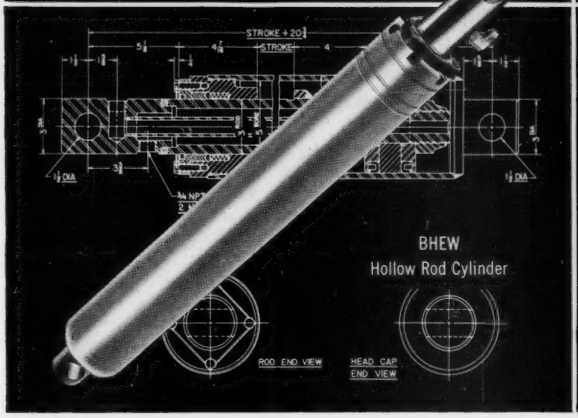


BHEW
'Dual Pilot' Check Valve

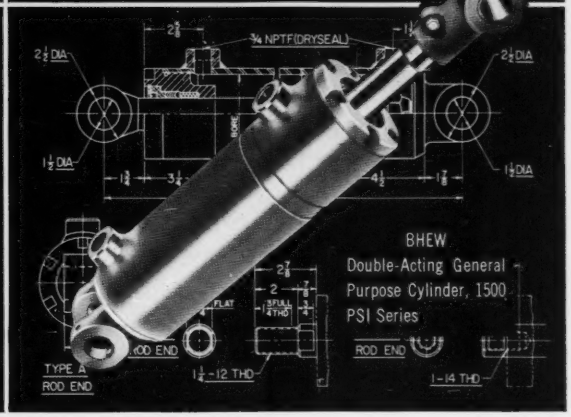


BHEW
3000 PSI Series General-Purpose Cylinders

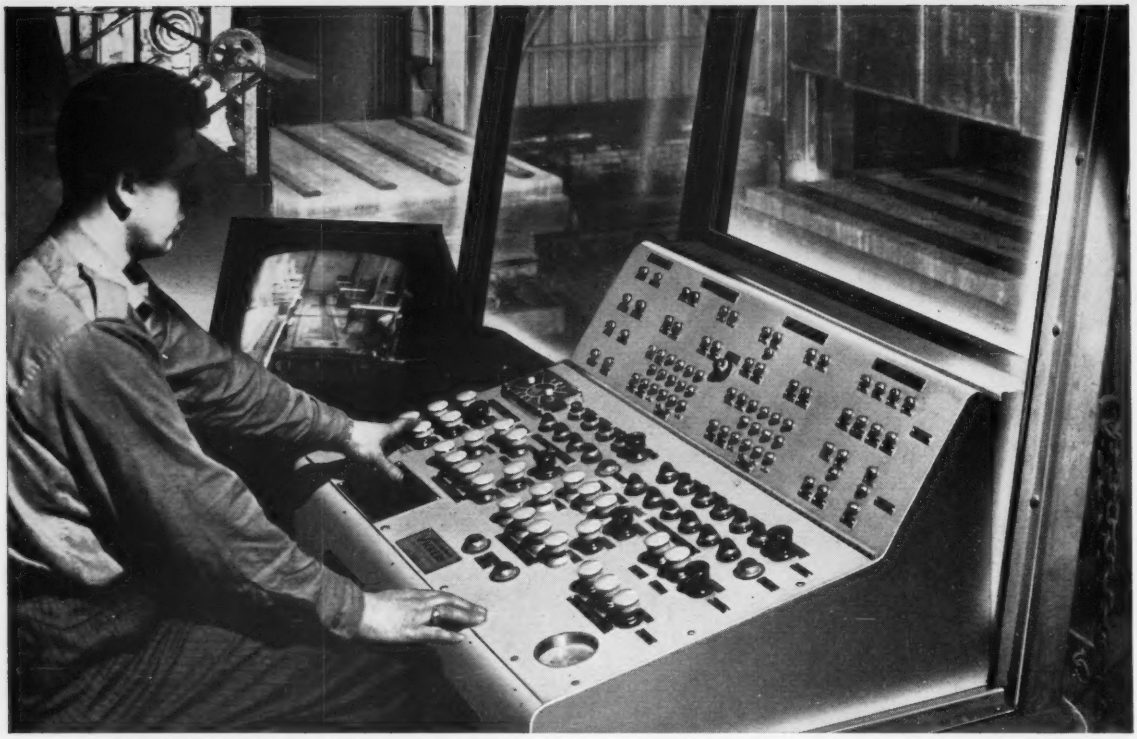
BHEW
Single-Acting General Purpose Cylinder, 1500 PSI Piston Style Series



BHEW
Hollow Rod Cylinder

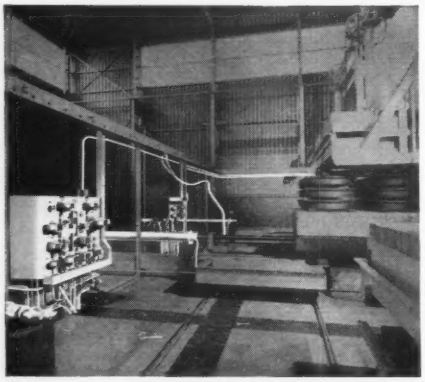


BHEW
Double-Acting General Purpose Cylinder, 1500 PSI Series



VICKERS® PACKAGED ELECTRO-HYDRAULIC SYSTEM

makes possible automatic heat treatment at Canadian Steel Wheel



Vickers control console at top of page gives operator remote control of normalizing furnace operations. Control console, power units, and valve panels like the one shown above are all part of the Vickers-Sperry package.

A combination of closed circuit TV and electro-hydraulic control permits a fully automatic heat treatment cycle for wrought steel wheels at Canadian Steel Wheel Limited's ultra-modern plant in Montreal. Depressing a selector button is all it takes to initiate a cycle. This new integrated plant can produce 200,000 wrought steel wheels per year to meet the increased needs of Canada's railways. This is accomplished by using the latest in automated manufacturing procedures and inspection techniques.

Vickers-Sperry of Canada Ltd. designed and manufactured the complete electrical and hydraulic control system for movement of wheels through the 90-foot long heat treatment furnaces. The complete "packaged" job included installation and startup of the equipment.

Although Vickers-Sperry "Packaged Systems" like this one are developed for specific installations, they use standard components throughout . . . thereby cutting original cost and simplifying maintenance because spare parts and service are readily available. You get not only single source convenience but *single source responsibility*.

A Vickers-Sperry application engineer can survey your requirements and show you how a packaged electro-hydraulic system offers the most efficient solution to your operating needs. Further information is available in Bulletin 59-74, write for your copy today.

VICKERS-SPERRY of Canada Ltd.

Division of Vickers Incorporated

SPERRY RAND CORPORATION

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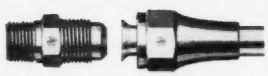

S.A.E. 45° FLARE
USED with copper, brass, aluminum, steel and plastic tubing. PRESSURE RATINGS up to 5000 p.s.i. **Sizes: ⅛" to ¾".** Also available in 37° heavy pattern brass. Listed by U.L.; approved by A.G.A. Meets specs of S.A.E. Hydraulic Tube Fittings Standards and A.S.A. and A.S.M.E. codes for instruments and control piping.

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USED with copper, brass, aluminum and plastic tubing. PRESSURE RATINGS up to 2000 p.s.i. **Sizes: ⅛" to ¾".** Listed by U.L.; approved by A.G.A. Meets specs of S.A.E. Hydraulic Tube Fittings Standards and A.S.A. and A.S.M.E. codes for instruments and control piping.

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No flaring, soldering, welding—insert tube and tighten nut. USED with copper, brass, aluminum and plastic tubing. PRESSURE RATINGS up to 2000 p.s.i. **Sizes: ⅛" to ¾".**

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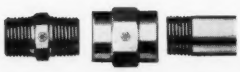

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USED with brass or steel pipe. PRESSURE RATING: up to 5000 p.s.i. **Sizes: to 2".** Meets specifications of S.A.E. TPHL Fittings Committee.

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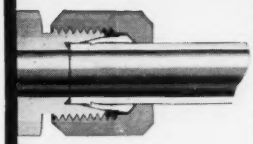

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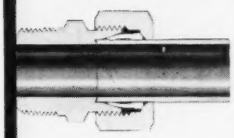
U.L. listed. Meets J.I.C. standards. S.A.E. approved "O" Ring boss design. Dryseal pipe thread. Needs no flaring. Available in either carbon or stainless steel. Carbon steel fittings have "Weathercoat" or cadmium-plate finish. PRESSURE RATINGS: up to 10,000 p.s.i. **Size Ranges—⅛" through 2".**



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Listed by U.L. for use with hazardous liquids, fuel equipment, refrigeration and gas; meets specs of S.A.E. and J.I.C. hydraulic tube fitting standards. Supplied as standard in cadmium-plate carbon steel and in stainless steel. Requires no flaring. PRESSURE RATINGS: up to 10,000 p.s.i. **Size Range—⅛" through 2".**

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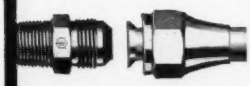

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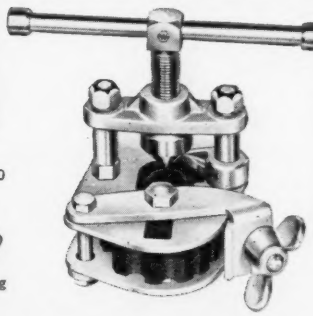

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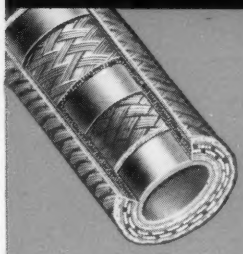

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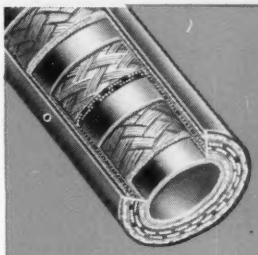

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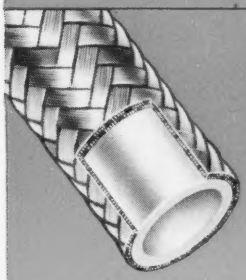

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male pipe fittings

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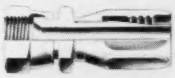

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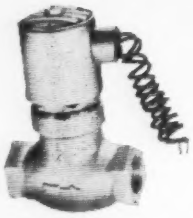

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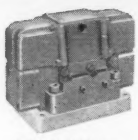
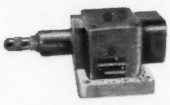


4 WAY VALVES

CONTROL PANELS



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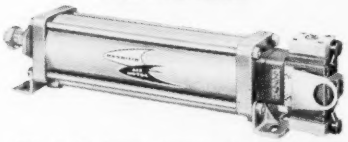
AIR MOTORS



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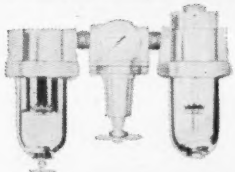

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MPB *Helps you perform miracles in miniaturization*

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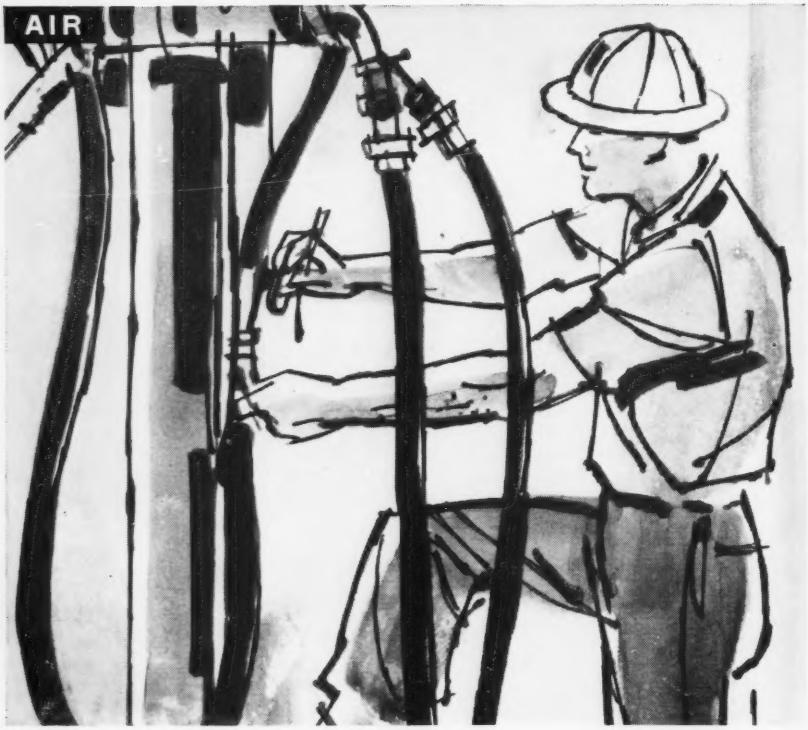
One "All-Purpose" Hose of Du Pont Neoprene Does the Work of Four Ordinary Hoses



You can cut maintenance costs and inventory, too, with "all-purpose" hose of Du Pont neoprene. Only neoprene synthetic rubber has a special combination of properties which lets you handle many different materials with one "all-purpose" hose. It can carry air, low-pressure steam, oil, and many chemicals. You no longer have to use and store many different type hoses.

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Look around your plant. Are you overstocked with different types of hose that could be replaced by neoprene "all-purpose" hose? If you are, cut your costs. See your local rubber goods distributor, and select hose made with Du Pont neoprene.

For your regular copy of "Elastomers Notebook" and more detailed information about neoprene, write to Du Pont of Canada Limited, 85 Eglinton Ave. E., Toronto 12, Ont.

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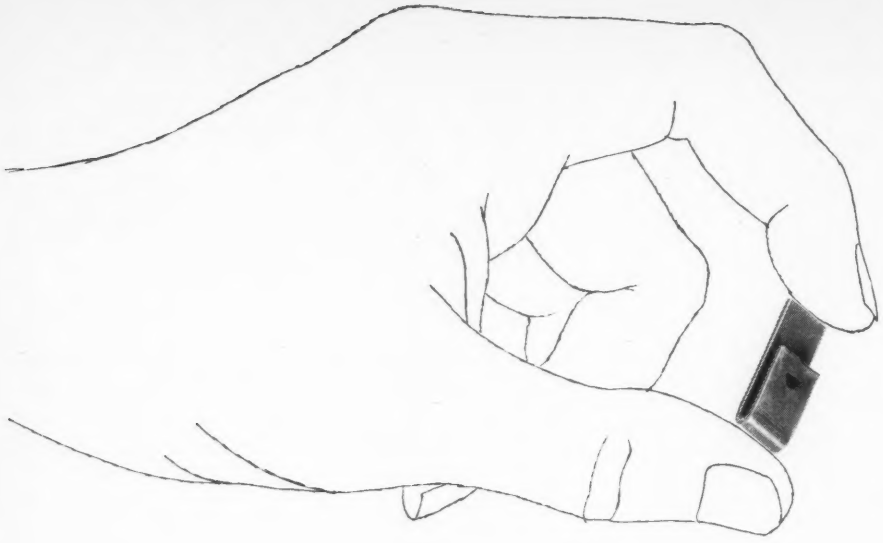

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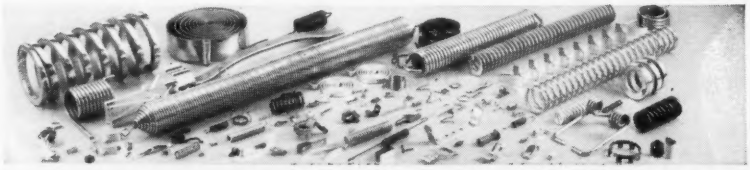

64-230

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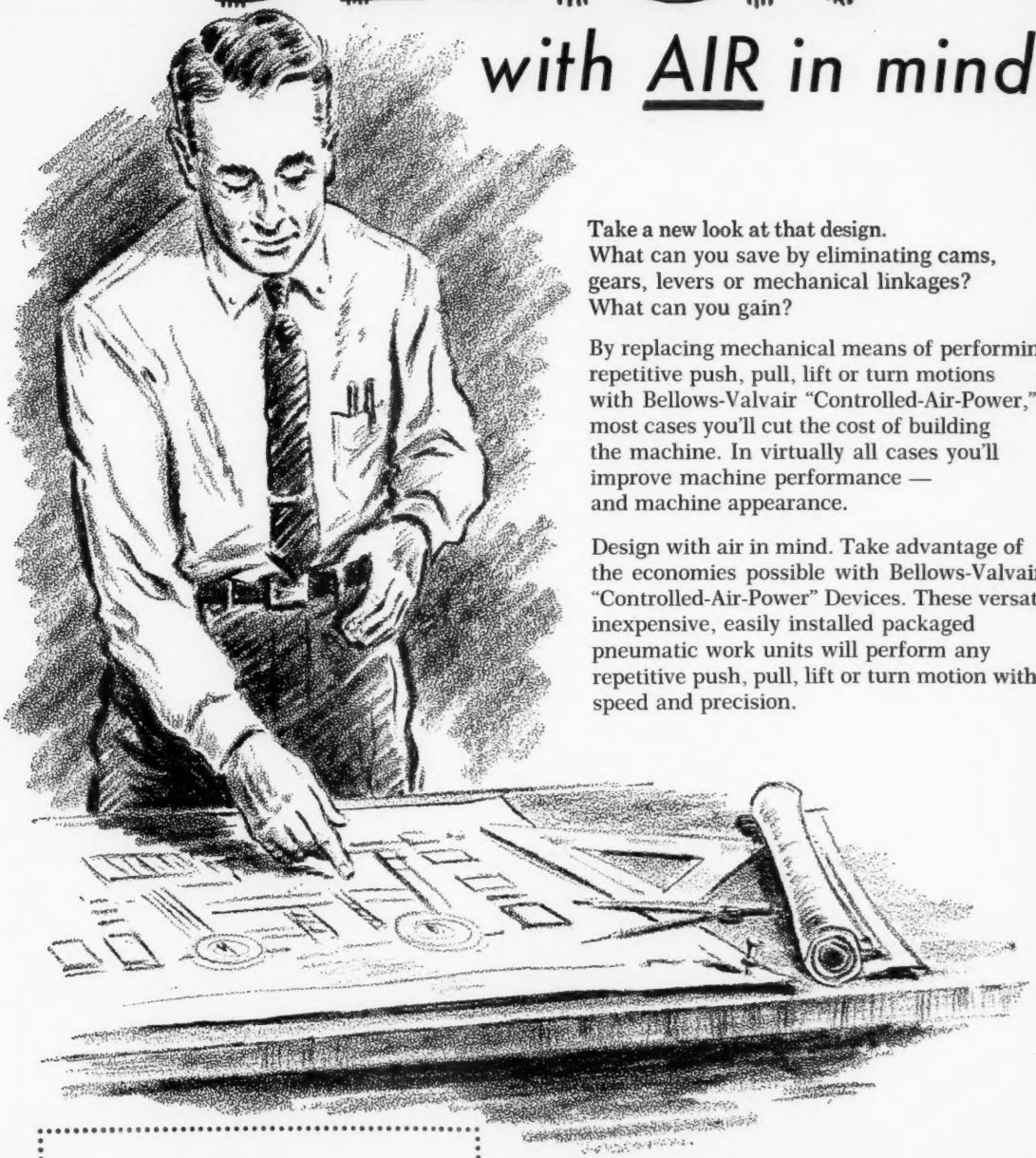
DESIGN

with AIR in mind



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What can you gain?

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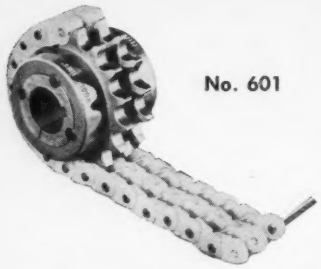
product news from — United Steel
CORPORATION LIMITED

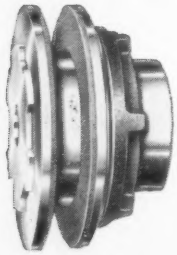


No. 601

Nylon chain coupling will outlast metal as much as 6 to 1 — costs less to buy

Specially suited for areas where heat, cold or corrosion are problems, or where quiet running is desirable, this nylon chain coupling will give as much as six times longer service life than metal couplings yet costs less to buy and maintain. Ideal for loads from fractional to 40 H.P. and speeds from 500 to 5,000 R.P.M. the nylon coupling is available for use with standard ½" pitch roller chain sprockets. Requires no lubrication and therefore no cover. Much cleaner than lubricated couplings.

No. 602



Torque Limiter is compact, easily adjusted and tamper-proof

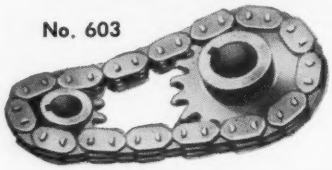
The Torque Limiter consists of a driving or driven member in combination with a spring loaded friction mechanism which may be adjusted to slip when the desired torque is exceeded. The unit is compact, easily adjusted and tamper-proof. It can be used in conjunction with any rotating member, such as sprockets, gears or pulleys. The Torque Limiter can be supplied to handle up to 620 ft. pounds of Torque.

Silent Chain is specially suited for use on precision machinery

This 3/16" pitch Silent Chain is designed particularly for applications where a smooth, positive drive is required; such as movie projectors, tape recorders, instruments and other precision machinery. It is manufactured in three basic types and is available to handle up to 5½ H.P. at 5,000 R.P.M.:

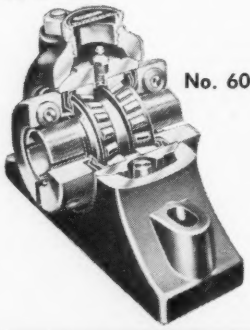
(1) Side Guide — for standard drives with single direction rotation, chains 19/32" and under.
(2) Centre Guide — for standard drives with single direction rotation, chains over 19/32" wide.
(3) Duplex Chain—for serpentine drives, reversing secondary shaft rotation, or if an adjustable idler is required.

No. 603



Roller Bearing Pillow Block for dusty operating conditions

The Type C (Dodge-Timken) Roller Bearing Pillow Block offers maximum protection where dust or other contamination is unusually severe. The Basic design consists of two Timken assemblies mounted on a slotted and threaded sleeve. These slotted ends are clamped to the shaft by means of split clamp collars. (The collars, threaded to the sleeve also provide means of adjustment). Labyrinth seals are located between the collars and the Timken Bearings. The Type C unit is completely self-aligning and provides for both radial and thrust carrying capacities. Available for shaft sizes from 1-3/16" to 5".

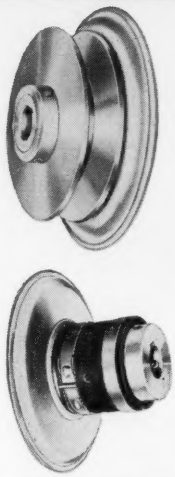


No. 604

Flexidyne Drives and Couplings provide cushioned starting— instant overload protection

Number 5 Flexidyne Drives and Couplings were developed especially for use on light machines which may be subject to jam-ups, for example: Automatic Washers; Bottling and Canning Machinery; Automation Machinery. These light inexpensive units provide cushioned starting and instantaneous overload protection, just like the larger Flexidynes which are available to handle up to 1,000 H.P.

No. 605



Roller Chain

Precision construction and carefully tested materials are important features of this high quality roller chain. Available in all pitches and lengths, in many varieties of construction and strength for every type of transmission service.

No. 606

All of the items illustrated here are available for immediate delivery from stock at United Steel Corporation. Drop us a line, or fill in the coupon below for an answer to your transmission problems.

MAIL COUPON TODAY

UNITED STEEL CORPORATION LTD.
58 Pelham Avenue,
Toronto 9, Ontario

Please send me descriptive literature on:

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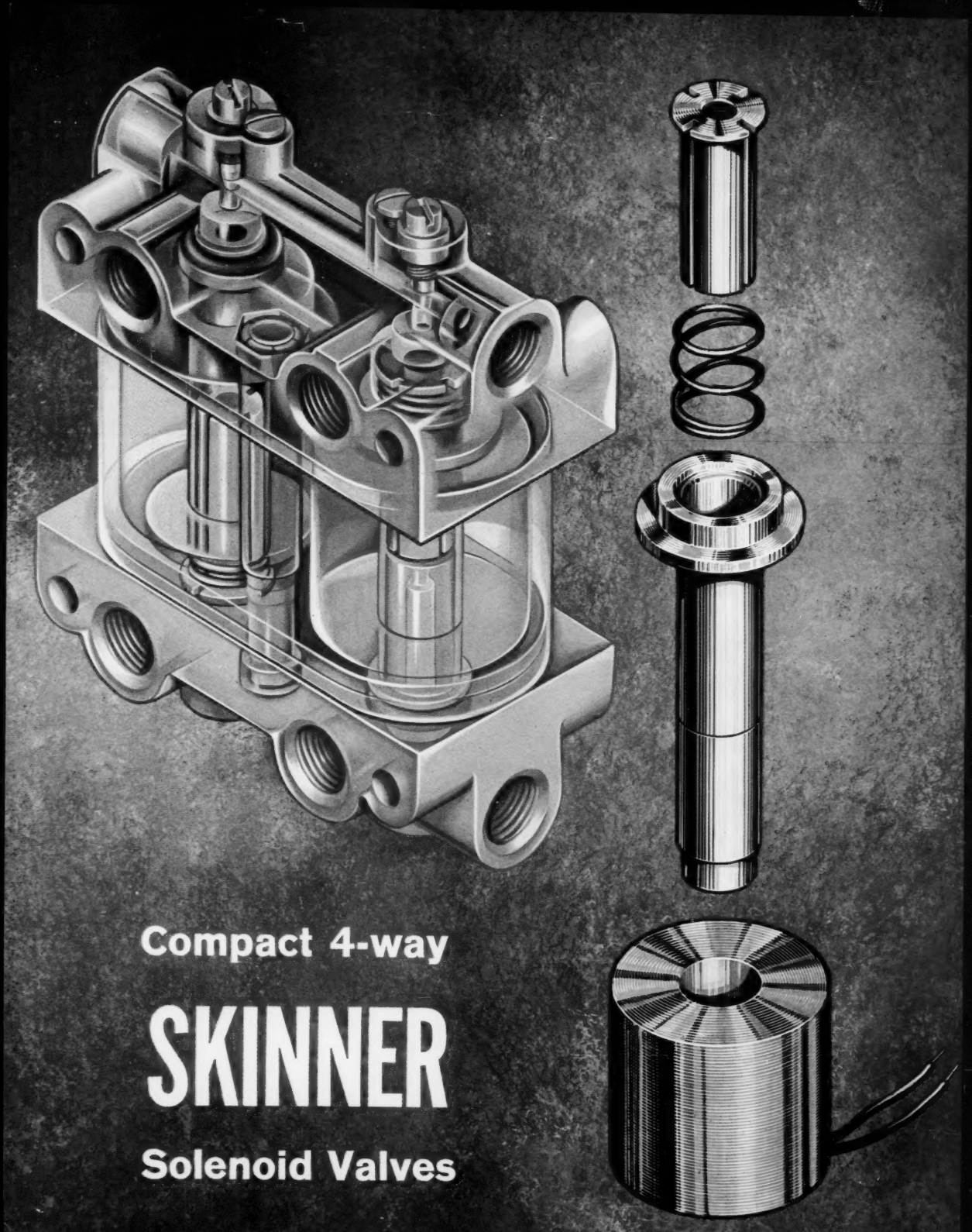


Compact 4-way

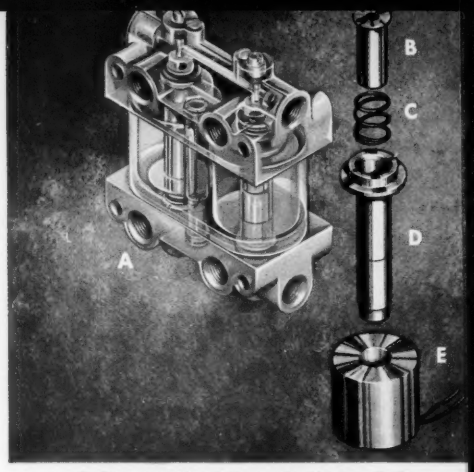
SKINNER

Solenoid Valves

assure precise cylinder control

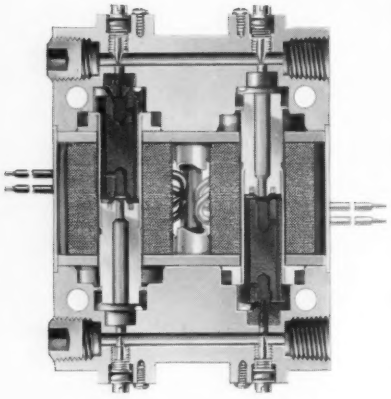
Here's how accurate, dependable operation is built into SKINNER 4-way solenoid valves

- **Precise flow control**—by adjustable metering
- **Compact, direct acting**—two 3-way valves in one housing
- **Durable and corrosion resistant**—stainless steel internal parts
- **Leakproof, bubbletight sealing**—soft, synthetic inserts
- **Positive operation mounted in any position**—spring-loaded plungers
- **Underwriters approved**—wide selection of coils, voltages and frequencies
- **Wired from front or rear**—housing easily reversed
- **Adaptable to many uses**—optional porting arrangements



A. Transparent view of 4-way solenoid valve B. Plunger C. Plunger return spring D. Sleeve E. Coil

SKINNER four-way solenoid valves available in three basic types



The Skinner V9 solenoid valve is two 3-way valves in one compact housing. Both valves may be independently controlled and metered to provide accurate, dependable control of single- or double-acting cylinders, or larger pilot-operated valves.

V9 types are available without adjustable flow and with metering at both exhaust ports, both inlet ports or full metering of all ports.

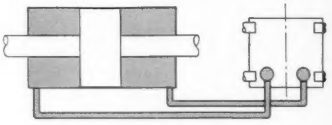
▪ ▪ ▪

For complete information, contact a Skinner Distributor listed in the Yellow Pages or write us at the address below.

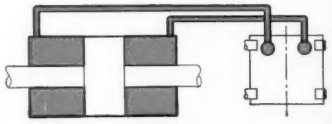
V9 SERIES SPECIFICATIONS

Media—air, hydraulic oils, inert gases
Orifice Diameter—$\frac{3}{64}$", $\frac{1}{16}$", $\frac{3}{32}$", $\frac{1}{8}$"
Pipe Size—$\frac{1}{4}$" NPTF
Maximum Operating Pressure Differential—0 to 150 PSI (up to 225 PSI also available)
Temperature Range—minus 40°F. to plus 180°F.
C_v Factor—$\frac{3}{64}$" .052, $\frac{1}{16}$" .095, $\frac{3}{32}$" .156, $\frac{1}{8}$" .214
Mounting—$\frac{1}{4}$" through-bolt holes.

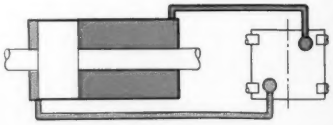
Normally closed—normally closed V933 valves with a neutral position. Generally applied on double-acting cylinders where the piston is in a neutral position without pressure when both coils are de-energized. This permits manual shifting of the piston without operating the valve.



Normally open—normally open V955 valves with a neutral position. Generally applied on double-acting cylinders where both sides of the piston are to be open to pressure when both coils are de-energized. Under certain conditions, the first operating stroke of double-acting cylinders will be smoother with this valve in use.



Normally closed—normally open V935 valves with no neutral position. Generally applied on double-acting cylinders where the piston is to be in retracted or extended position with pressure when both coils are de-energized. Wiring is simple—both coils are operated simultaneously and can be controlled by one single-pole, single-throw switch.



When you specify solenoid valves, specify Skinner. Skinner solenoid valves are distributed nationally.

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THE CREST OF QUALITY

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PRINTED IN U.S.A.

IN REMOTE CONTROLS MARSLAND has made a good name

. . . and that name is "LEDEX"

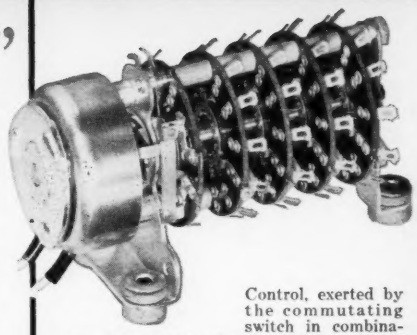
Rotary Solenoids • Circuit Selectors and Stepping Relays

In properly designed applications rugged, shock proof "Ledex" Rotary Solenoids will perform their operation millions of times consecutively without special care or maintenance. Combined with rotary type wafer switches they provide many versatile designs of stepping, counting, adding and subtracting, latching and circuit selecting relays, for both DC and AC power supplies.

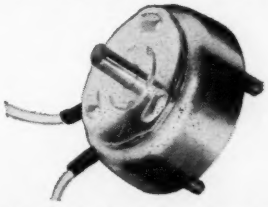
An extensive number of mechanical features are available in 8 basic sizes in a wide voltage range to meet all requirements.

Marsland Engineering have made many special assemblies to customer requirement. Marsland will design and build custom equipment utilizing Rotary Solenoids, and will co-operate in strictest confidence at the design level on problems or equipment involving remote control.

Manufactured and sold in Canada under license from G. H. Leland Inc., Dayton, Ohio by "LEDEX" Rotary Solenoid Division of



Control, exerted by the commutating switch in combination with the control wafer switch makes it possible to select multiple circuits connected by a single manually operated switch. Circuit wafers are made with 8, 10, 12, 18 and 24 positions and provide many combinations. The 12 position switch may utilize factors of 12 . . . 1P-12T, 2P-6T, 3P-4T or 4P-3T.



"Ledex" Solenoids have employment ranging from control of small precision mechanisms to the actuation of rugged components in heavy duty equipment. They provide remote control and reduce the number of mechanical parts required.

MARSLAND ENGINEERING LIMITED

154 Victoria Street, Kitchener, Ontario.

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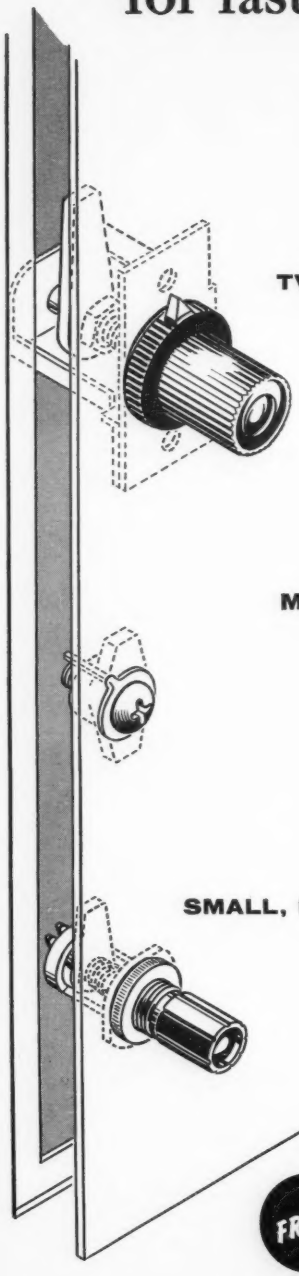
Standards with unique features for fastening doors and panels

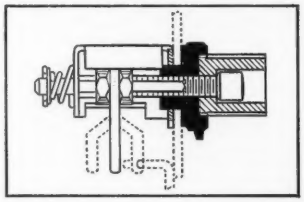


Southco adjustable pawl fasteners are easy and economical to install, give a "class" appearance to equipment. They apply controlled pressure to seal tightly and stop rattles.

TWIN KNOB CONTROL—NO. 46

The pawl engages the frame when the actuator is turned 90°. A bright chrome button in the center of the knob is preset for the amount of pressure to be exerted by the fastener. After the pawl engages the frame, the knob is turned until the button is flush with the knob surface. Preset pressure is thus obtained.

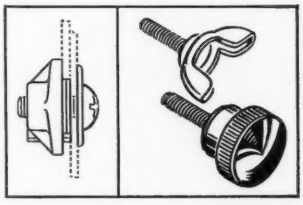
Materials *Body: Cadmium plated steel*
Knob: Black nylon



MINIATURE ENVELOPE—NO. 45

Requiring a minimum of space inside and outside, this fastener latches on a 1/4 turn and additional turning pulls up the door or panel against its frame. The nylon pawl operates smoothly against metal and provides exceptional wearing qualities.

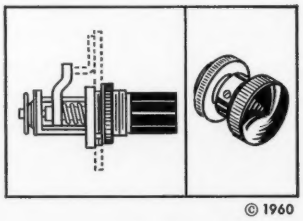
Materials *Pawl stop and washers: Carbon steel, cadmium plated*
Pawl: Nylon, natural



SMALL, HEAVY-DUTY MOUNTING—NO. 48

Small, rugged, compact. One quarter turn closes, additional turning tightens. Quickly installed with a single mounting nut. Three sizes cover every frame thickness from .000 to .750. Can be supplied with flatted shaft for your knob.

Materials *Body and pawl: Steel, cadmium plated*
Knob: Black nylon



FREE! **Your copy of Southco Fastener Handbook containing engineering data on wide selection of fasteners. Write to Southco Division, South Chester Corporation, 000 Industrial Highway, Lester, Pa.**

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SOUTHCO FASTENERS
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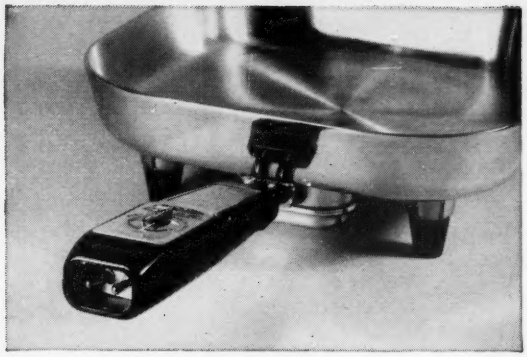


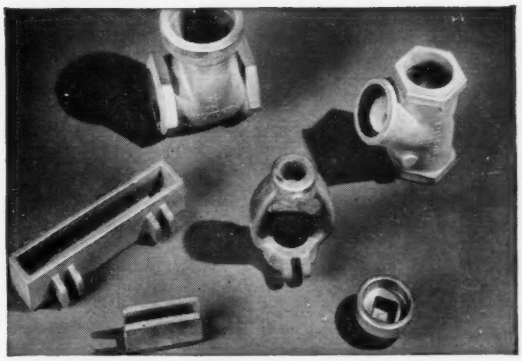
1 The handle of this automatic fry pan is molded of phenolic to:
(a) stay cool *(b) fit small hands*
(c) insulate inner wiring

2 In 18 years, it's been re-coated with phenolic paints:
(a) 2 times *(b) 5 times*
(c) 9 times

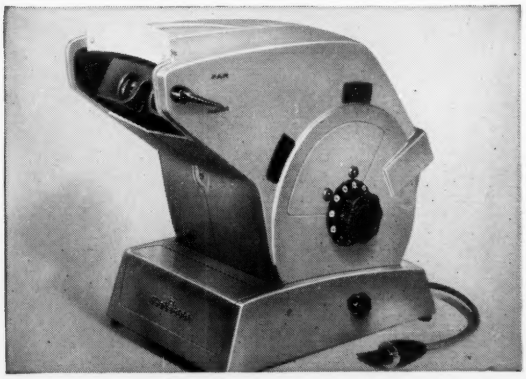
Can you pass this test on Phenolic Plastics?

(You'll profit by knowing them better)

3 This modern electronic circuit is *printed* on a base of:
(a) molded phenolic *(b) phenolic-impregnated paper laminate*
(c) phenolic-coated metal



4 These smoother-finished metal castings result from:
(a) phenolic-bonded shell molds *(b) phenolic-based coatings*
(c) phenolic-bonded grinding wheels



5 This device to test vision has a molded phenolic case that:
(a) cuts weight 50% *(b) needs 25% less tooling*
(c) requires no coating

ANSWERS... *to design and production problems throughout industry are found in dependable BAKELITE phenolic plastics.*

1. Check (a) and (c), and add durability.
2. (a) Twice—phenolic paints last 7 years on the San Francisco Bay Bridge.
3. (b) A laminate—machineable, chemically inert, and non-conductive.
4. (a) Lightweight shell molds that virtually eliminate machining.
5. Check (a), (b), and (c)—it saved all around.

If you have questions—about phenolics and their potential for your business—please ask us. Why not discuss the matter with a Bakelite Technical Representative? Just write or call any of our offices, or write Bakelite Company, Division of Union Carbide Canada Limited, 40 St. Clair Ave. East, Toronto 7.

UNION CARBIDE

BAKELITE and UNION CARBIDE are trade marks.

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Meet a specialist...

He's a Dominion Fasteners sales engineer, and he specializes in saving Canadian manufacturers *time* and *money*. Thoroughly trained and experienced in all fastening procedures, he can quickly analyze your product, showing you where Speed Nuts can cut product assembly time, lower production cost, and actually improve your product.

There are over 8,000 different sizes and types of Speed Nuts in use today. One of these will probably be suitable for your operation. If not, the designers at Dominion Fasteners can develop a fastener to meet your specific requirements.

Because you're a manufacturing "specialist", you'll want the complete story about Speed Nuts and savings.

DOMINION FASTENERS LIMITED, Dept. A62
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a Geo. A. Tinnerman *corporation*

Rush me complete information on how Speed Nuts can save me time and money, and make my product more competitive.

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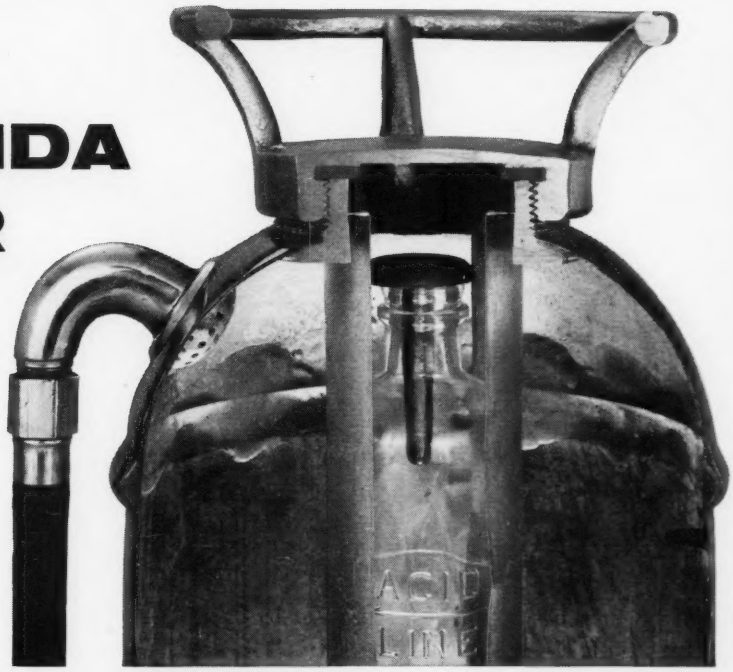
NORANDA COPPER

IN THE *Guardian* LINE



FAMOUS FOR LONG LIFE AND CORROSION RESISTANCE

Noranda copper is the choice of Wilson & Cousins Ltd., Toronto, for their "Guardian" line of all-copper fire extinguishers. The long life and corrosion resistance of Noranda copper, especially important in soda-acid type extinguishers, is further enhanced by copper's ease of fabrication and solderability.

Call Noranda for complete information or technical assistance.

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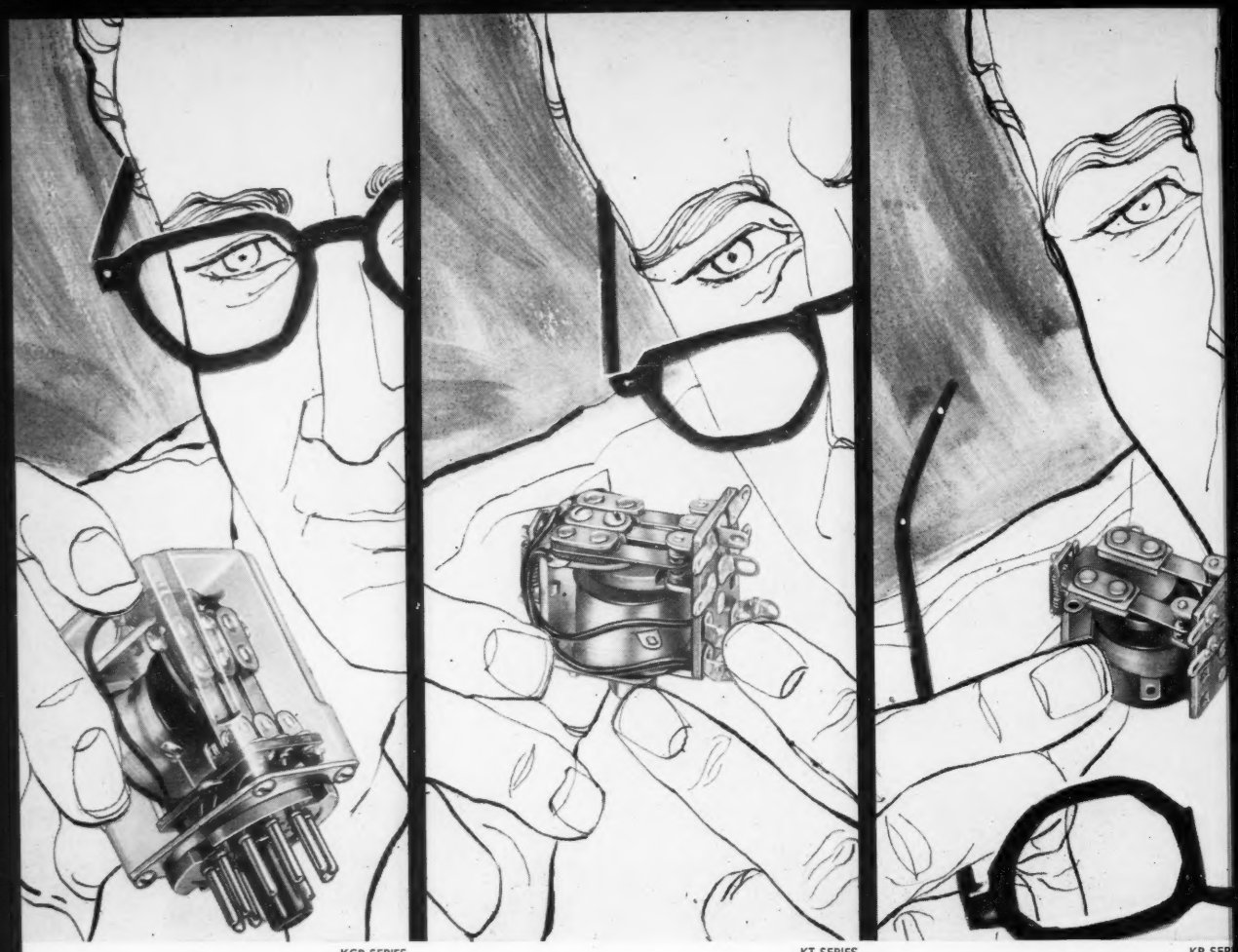


KCP SERIES KT SERIES KR SER

three for dependability at low cost

MEET P&B's FAMILY OF "K SERIES" RELAYS

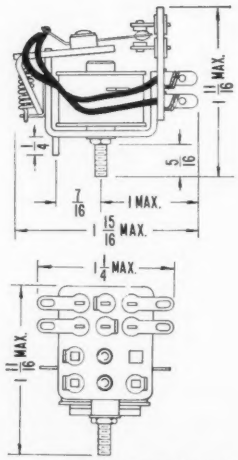
Here are only three of a large family of "K Series" relays by P&B. Blood brothers all, they are distinguished by fine craftsmanship and design maturity. Together they will handle a multitude of switching requirements.

Many design engineers find it saves time, saves money to integrate their circuits with *related* P&B relays. Makes sense, doesn't it?

KR—A small, lightweight relay used widely in communications and automation. Engineered for long life and dependability. 3PDT max. AC or DC. (See engineering data.)

KT—Designed for antenna switching. Capacitance: 0.5 mmfds between contacts. Terminal board is glass melamine and stack insulation is glass silicone for minimum RF losses to switch 300 ohm antenna line. 3 PDT max. AC or DC.

KC—Low cost plate circuit relay with sensitivity of 125 mw per pole. Factory adjusted to pull-in on specific current values. Available open, hermetically sealed or in clear plastic dust cover with standard octal-type plug. 3 PDT max. DC.



KR ENGINEERING DATA

GENERAL:
Breakdown Voltage: 500 volts rms minimum between all elements.

Temperature Range:
DC Coils—45°C to 85°C.
AC Coils—45°C to 70°C.

Terminals:
Pierced solder lugs standard. Octal 8 and 11 pin plug-in headers available.

Enclosures: Type K—Hermetically sealed.
Type P clear cellulose acetate dust cover.

CONTACTS:
Arrangements: 3 Form C (3PDT) max.
Material: 1/8" dia. fine silver (gold plated).
Other materials available to increase contact capacity.
Load: 5 amperes 115V 60 cycle resistive.

COILS:
Resistance: 16,500 ohms max. AC or DC.
Power: 1.1 watts minimum to 4 watts maximum for DC at 25°C ambient.
Duty: Continuous.
Insulation: Centrifically impregnated with insulating varnish.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

POTTER & BRUMFIELD CANADA LTD.

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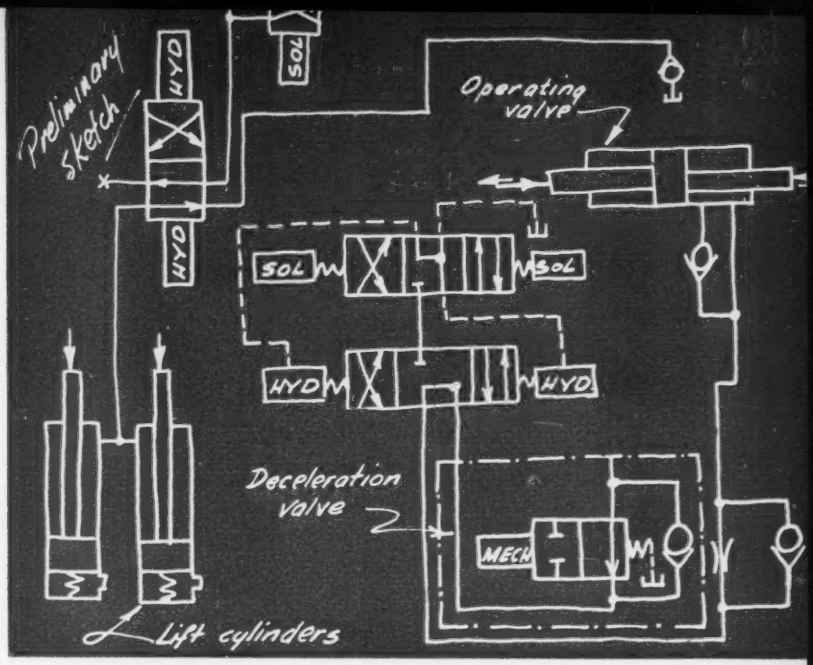


Design Engineering

AIR versus OIL—is there really any argument?

Both systems have their points; air offers speed, flexibility, low pressures — oil, durable control and heavy loads

C. P. Farr
Manager, tooling facilities
Massey-Ferguson Ltd., Toronto

Every engineering library is well stocked with literature on both pneumatic and hydraulic applications and circuitry. If you want to know something about either subject, there's never too much trouble finding good published material.

But it's a very different story when you have to decide on the merits of pneumatics versus hydraulics for your particular project. On the subject of comparisons the references are generally quite silent.

In a situation like that the engineer usually makes a decision based on his own experience and on the equipment he knows best. Unfortunately, such a decision doesn't always exploit the basic advantages of both systems.

Most of us are inclined to tackle a problem in one direction only. Like a good chess player, we should consider all the alternative situations.

To check yourself on this mental attitude, consider this problem. A bus begins a trip with one passenger. At the first stop, three people get on; at the next stop, four get on and two get off; at the next stop, three people get on one gets off; at the next stop, five get on; and at the last stop, two get on and four get off.

Now, without checking back, how many stops did the bus make? Do you know? Did you expect only the obvious question of how many passengers were on the bus or were you prepared for the alternative one?

When considering a problem we should train ourselves to consider all the possibilities and not limit ourselves to the obvious.

Many engineers in plants automatically think in terms of air, because it is usually available throughout the plant and because they are more familiar

continued

with its uses. They theorize that air costs nothing and therefore air controls cost less than hydraulics. This of course is the shortsighted viewpoint — compressed air costs come high considering the high capital cost of air compressors, receivers, and the constant maintenance required. Aside from this, the actual cost of compressing air is inefficient compared to oil hydraulics. For 1 hp applied to compressed air, only .385 hp is used for oil. (Marks Handbook, Section 14-50).

some notes on the power factor problem

In some plants, the power factor on huge compressors is also a serious consideration. When the air system becomes overloaded, major capital expenditures are required to increase the air capacity in the plant. With hydraulic power, on the other hand, numerous independent systems make for more reliable operations, since a failure of one unit will not shut the plant down. In addition, an infinite number of applications can be added without any fear of the power source running out.

There are many advantages in both pneumatic and hydraulic systems. In air we have the advantage of speed and flexibility, and economy when purchasing equipment. With hydraulics we have a more stable, more durable control, as among other things, it is self-lubricating. It is a more efficient operation, as we are only using energy when we want it.

However, a hydraulic installation usually costs more than a pneumatic for the same application (assuming air is available throughout the plant) as we have to purchase a hydraulic power pack consisting of a pump, motor and tank for each installation. This, of course, permits independent operation of any piece of equipment in the plant, and the system is not subjected to varying pressures as the case may be at times with a central air supply system.

Air is most commonly used in a manufacturing plant to blow off chips and clean out fixtures. While this is very effective, it presents a hazard to the operator and equipment. A stream of coolant directed into a fixture can be equally effective, with no dangerous side effects.

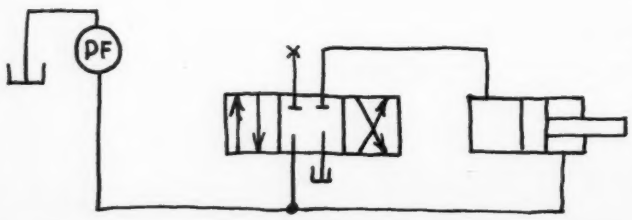
Next most popular application is clamping, which can take the form of a power chuck, a power vise, a tailstock of a machine, or work-holding clamps in fixtures. Normally, air clamping is popular because it is fast acting, inexpensive to apply, and clean to operate. Clamping power is limited to the cylinder area times the line pressure, and the size of the cylinder is generally limited to the space available. If heavy clamping forces are required, a hydraulic system should be utilized. This permits the engineer to more easily design clamping arrangements and cylinders into confined space without sacrificing force. With the high pressure pumps on the market today, amazing forces can be applied in surprisingly small spaces.

how fast and what is the load?

Another common application is actuation of movements; i.e., push, pull, lift, turn. Here the prime considerations are time and force. How fast and how powerful will decide whether the movement should be pneumatic or hydraulic. For instance, on resistance welders, pneumatic power is used to obtain a rapid follow up, as the metal being welded melts suddenly and quick action is desired to fuse the parts.

Hydraulic systems can be made to act quickly, but not as fast as with pneumatic systems. Pneumatics virtually utilizes the expansion of gasses (which travel faster than sound) whereas hydraulic motion depends on volume and displacement of liquid. Much can be done to speed up hydraulic action by the use of accumulator or differential circuits.

In the case of the hydraulic accumulator, gas (usually nitrogen) is compressed in a container by pumping oil into the container, compressing the gas.



Differential circuit— exhoust port closed— return from cylinder supplements pump delivery

Oil released from the accumulator supplements oil delivered from the pump and speeds up the movement of the cylinder.

This arrangement provides, in effect, a pneumatic-hydraulic circuit, so that a considerable volume of oil is stored under pressure in addition to the output of the pump. This combination will provide fast delivery of oil to the cylinder, imparting a rapid movement to the piston and rod. The speed is controlled by the oil viscosity and the restriction of the control valve or pipe size.

Differential action is another popular method of obtaining fast action with hydraulics. It differs from the conventional circuit which delivers oil from a pump to either the head or rod ends of a cylinder. In a differential circuit, a special valve connects the head and rod end together so that oil displaced from the rod end supplements the oil being delivered from the pump. Usually a 2 to 1 area differential is used in the cylinder, which doubles the forward speed when compared to a conventional circuit.

combine air and oil? why certainly

In some cases, devices are utilized where the two media are combined. Air is the motive force and the actual movement is controlled hydraulically—this scheme uses the best qualities of both methods, but is limited to relatively low forces.

The form of metering the oil through an adjustable orifice is basic to most hydraulic feed controls, but is considerably refined in comercial hydraulic flow control valves. For example, when you are watering your lawn through a nozzle (an adjustable orifice) attached to a garden hose, a pressure drop caused by someone in the house turning on a tap will immediately reduce the flow of water through the nozzle to a miserable trickle until the bleed off is stopped and full pressure returns to the hose line.

Manufacturers of hydraulic flow controls guard against this varying pressure by reducing the line pressure to a constant low pressure value of, say 20 psi, and then metering the flow through an adjustable orifice. This compensates for all normal variations in line pressures, provided the flow doesn't fall below the constant value.

This design allows a much larger orifice opening to be used, as we are metering oil from a lower pressure (20 psi) source. The orifice will not clog up with lint, dirt and impurities in the oil as would be the case if we tried to meter the direct uncompensated high pressure coming to the flow control through a tiny orifice. Some companies have further refined this pressure compensate flow control with temperature compensation. As the oil heats up, it thins out and obviously will flow faster through the orifice. They therefore partly close the orifice automatically as the oil heats up and thins out, and by means of a thermostat maintain an almost constant flow rate through the orifice. Now we have a pressure and temperature compensated flow control valve in one compact unit.

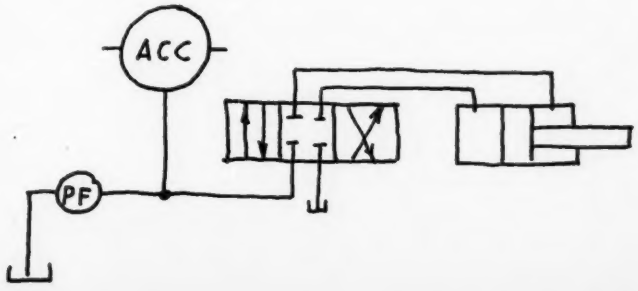
motion control is easy!

Controlling motion by metering is commonly used in industry. The most accurate means of accomplishing positive control is to make use of a displacement circuit.

In this case, the movement of the cylinder is controlled by the volume of oil displaced by the pump.

If we have a fixed delivery from a pump and all the oil displaced by the pump is delivered to the cylinder, we will have a fixed rate of movement of that cylinder. This system is generally very accurate, as oil is virtually incompressible, so a variation in pressure will not affect the rate of movement; nor will a change in viscosity, except for a minor increase in internal leakage within the pump. To overcome this, a piston type pump is used and which is very efficient. This will almost eliminate internal leakage until the pump has developed considerable wear through use.

Oil from accumulator supplements pump delivery and speeds up movement



continued ▶

If we want a variable volume such as is required for variable feed rates on machine tools, we employ a variable volume piston type pump which is readily purchased on the open market.

This type of motion control is the most positive, but is generally more expensive than the more commonly used metering out system. The job requirement will usually determine which system to apply. For example, if we are going to feed a carbide tool into metal at a feed rate of .010 inches per revolution, we would use a displacement type hydraulic circuit for best results; but if we were going to control the reciprocation of a table of a surface grinder, a metering system would be perfectly adequate and less expensive.

Control of feed rates is extremely important in machine tools, since the time required to perform the operation should be constant from a method-time-measurement point of view, to enable accurate standards to be set, since these ultimately determine the cost of the production.

We also have the very important factor of cutting tool life to consider. Feed variations spell death to good tool life, and bad tool life means costly downtime to replace tools, upping the cost of production.

air and oil competitive? well — not really

In general, the two media, compressed air and hydraulics are not competitive, although there is sometimes a certain amount of overlap. The big difference is, of course, in the pressure range covered. Pneumatic equipment rarely operates at pressures higher than 150-180 psi, whereas with industrial hydraulics, pressures in the region of 2,000 psi are commonplace. In the aircraft industry, where lightness is essential, pressures are slightly higher, up to about 3,000 psi, and in the field of heavy press manufacture where the total forces involved are very great, pressures as high as 5,000 psi are encountered.

The fact that air is compressible has been the main reason for the employment of comparatively low pressures. In the event of a pipe fracture, high pressure air could be extremely dangerous. In the case of a virtually incompressible fluid such as hydraulic oil or water, failure merely results in leakage.

The compressibility of air is also the key to its various advantages and disadvantages. Being compressible it is a useful source of stored energy; in fact, a large amount of potential energy can be stored in quite a small space. This is not possible with hydraulics, where accumulators containing springs or compressed nitrogen must be used if power storage is required.

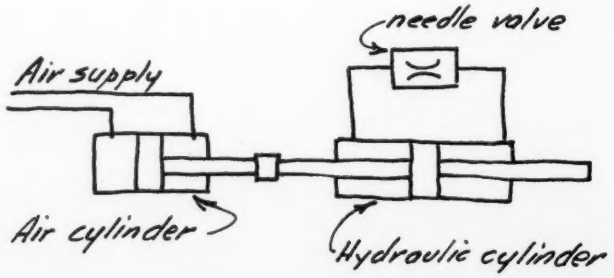
To summarize, air as a medium is cheap, expendable, fireproof, fast-acting, easily stored, easily controlled by means of simple valves, easily transmitted by means of simple piping. Hydraulic oil is comparatively expensive, may constitute a fire hazard, and leaks in the system can readily lead to failure.

However, the high pressures possible with hydraulics give an extremely high power-to-weight ratio and the nature of the medium gives very precise controlled movement. One final advantage with hydraulics, of course, is that "hydraulic locking" is possible without the need of complicated external mechanical wedging or clamping. Farm implements utilize this feature extensively. Blocking the oil in the lines with a valve permits holding the implement in a hydraulically locked position.

the final choice belongs to the engineer

The final decision, then, of whether to use air or oil for a particular application is rarely a simple one, especially in those areas where the two systems overlap. Certain key factors will affect the decision. Included will be the availability of air, space limitations, the environment, the availability of the proper components — and lastly, but by no means the least, the economics of the situation. Only the design engineer who is well informed on all these matters can make a sound and logical decision. ★

Combined air and oil circuit provides excellent control



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An introduction to fluid power circuits

Essential to have the right combination of valves and cylinders

The applications of fluid power are limited only by the vision of those using it. As in most subjects however, the basic means of communication and recording must be understood before any real progress is made.

The recognition of fluid power as a major factor in industry has been comparatively recent, but because of its adaptability to automatic function, the growth of its use has been nothing short of phenomenal. Circuitry is an even more recent innovation and has progressed rapidly beyond the simple form into complex combinations of valves and cylinders which will control an entire machine.

The fluid power circuit has developed because of its cost and installation advantages. Once designed, it can be presented as a piping diagram, but during the design stage, the actual flow pattern must be clearly traceable. It is also necessary to preserve this record for future additions to the circuit, the inclusion of another valve in a circuit often making a complete change in its behavior.

In view of the complexity of some circuits, a series of symbols has been developed to represent the various control forms available. The American and British standards are slightly different, but both very specific and, knowing one series, there is no difficulty in deciphering the other. These symbols have to be completely elastic in order to accommodate the latest developments in controls, which now often incorporate, in one valve, features which would previously have required several different units.

In consequence, the symbol rarely bears any physical resemblance to the valve it represents and a circuit diagram becomes a rather fearsome array of lines and boxes, completely understood only by those familiar with the symbols.

While such symbols are essential for the final presentation of a circuit, they are somewhat cumbersome to draw and do not readily indicate the flow pattern at any one particular phase of the operation. Therefore, when designing a circuit, it is common practice to use a form of "shorthand" to represent the valves employed. A selection of such forms are illustrated by figure 1 and it will be noted that these are very easily sketched, yet show the flow through the valve very clearly.

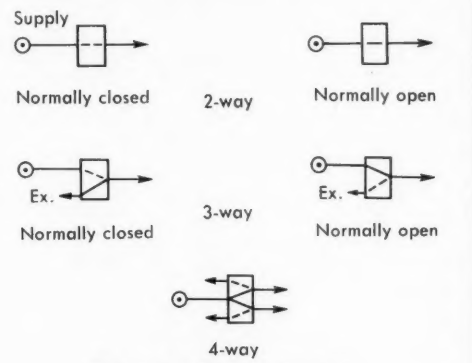

Figure 1—Symbols for valves

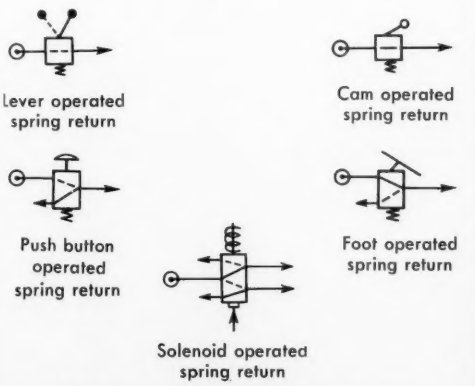

Figure 2—Valve operating mechanisms

Basic equipment review

Details of all graphic symbols are readily available from most valve manufacturers, but the basic information concerning the function and use of various units is sometimes overlooked as general knowledge. It would seem appropriate therefore, in an introduction to circuitry, to review such equipment.

Cylinder, single acting — This is used to describe any cylinder where pressure is used on one side of the piston only. This means that, having been pushed forward, the piston must be returned to its original position by another force, usually a spring, but in some cases the load on the piston is used. Manufacturers invariably use this term to denote a cylinder with an internal spring for returning the piston.

Cylinder, double acting—The most commonly used type of cylinder, this uses pressure on both sides of the piston and can be used to pull or push with almost equal force (the "almost" is due to the deduction of rod area from that of the piston on the pull stroke). In circuitry, it is important to remember that the medium on one side of the piston must be allowed to escape when movement is required.

Valve, 2-way, straightway or shutoff — These three terms are in general use to describe the basic valve form, which is a passage able to be closed or opened at will.

Valve, 3-way — This valve has two passages and is therefore a combination of two, 2-way valves. Nor-

continued

mally these passages are arranged so that one is open when the other is closed and vice versa. Thus, pressure can be passed through the valve to a container via one passage, and released by opening the other. By itself, the 3-way valve will operate a single acting cylinder.

Valve, 4-way—A combination of two 3-way valves, or four 2-way valves, this valve has four passages, two for pressure and two to release it. It is used to control a double acting cylinder, automatically releasing pressure from one side of the piston as it applies pressure to the other.

It will be seen from the description of the valves that the position of the passages, whether open or closed, determines the position of the cylinder rod and is therefore of the greatest importance. Figure 2 illustrates the same valves with various operating mechanisms and this is the basic valve material a designer requires to form a circuit.

A large proportion of fluid power applications are based on direct control, that is, a manually operated valve controls one cylinder. In its simplest form this would be represented by a clamping operation, where a cylinder is used to hold an article while work is in progress. The cylinder is moved forward to clamp, and withdrawn to release, by the manual operation of the valve.

Basic circuits simplified

This basic circuit is shown by figure 3, with one cylinder and one valve. It will be appreciated from this, that if the operator controlled two cylinders which operated simultaneously, he would still only require one valve. If, however, individual control of each cylinder was required, two valves would be used and the circuit as shown would merely be duplicated.

In a machine which has no prescribed sequence of operations, such as a bulldozer, loader, excavator or even a mill, this will result in an imposing number of controls, but the basic circuit will be simply a multiplication of figure 3.

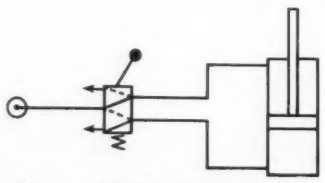

Figure 3—Basic hydraulic circuit

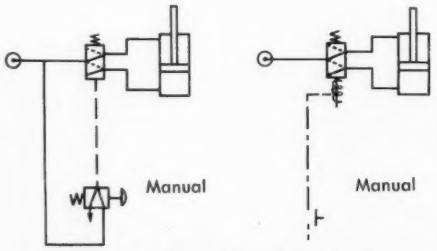

Figure 4—Remote control circuit

The application of direct control can be carried further into remote control by the addition of pilot lines or by an electrical circuit. In the former, the main valve is operated by a small cylinder at either end, operated in turn by a pilot valve. When a pilot valve is operated, the pressure admitted to the cylinder at one end of the main valve pushes the piston and operates the valve. When pressure is released, the return spring of the valve forces the piston back and resets the valve to its original position. In an electro-hydraulic circuit, a solenoid is used instead of the cylinder on the valve and, by energizing this solenoid, the same condition is obtained. These circuits are shown in figure 4. This arrangement permits the main valve to be located in close proximity to the cylinder it controls, reducing time lag in operation and, if air is the media, resulting in a considerable saving of the quantity used.

Automatic control circuits

It would be well to note at this point that the balanced spool type of valve is very much favored for circuitry. With this valve, the spool having been moved into position, will stay there until returned by an outside force. Thus, if no spring is employed to return it, only an impulse, or signal is required to set it in the position required. In this case, receiving a signal to send the rod of the cylinder forward, regardless of whether this signal is maintained or not, the rod of the cylinder will continue to move forward until the counter signal is received. This means that the movement of the cylinder itself can be used to give this counter signal when a predetermined point has been reached, as shown in figure 5, again with both a fluid and an electrical circuit. The important point to remember is that the signal or pressure initiating the valve in the first place must be released before the valve spool can return.

From this, the automatic reciprocation of a cylinder is a simple matter, a limit switch or pilot valve being situated at each end of the stroke. By cutting off the supply to the appropriate pilot, the piston will also be stopped, extended or retracted as required.

The initiation of a pilot valve does not necessarily have to control the same cylinder. Figure 6 shows the circuit for a series of cylinders operating in sequence, one after another as the previous cylinder reaches the end of its stroke. At the end of the sequence, all cylinders are returned to the retracted position by cutting off the pilot supply. This type of circuit would be useful where a clamping operation followed by the application of a number of tools is required.

A more advanced circuit for the same application would require the clamping operation to be maintained while the tools advance and retract in sequence. This circuit is detailed in figure 7 and it will be seen that, once again, the tools have to reach the point required and then fully retract before the next tool advances.

This is basic circuitry. The text has dealt with standard valves and cylinders. From these alone an infinite variety of combinations, movements and operations can be devised. In addition to these basic units there are virtually thousands of special valves, cylinders and controls designed to make circuitry easier to increase its range. The use of fluid power, universal though it is, has not reached its maximum by any means and new applications are appearing every day. The ambitious designer must be fully aware of its potentiality and capable of incorporating it into his design. ★

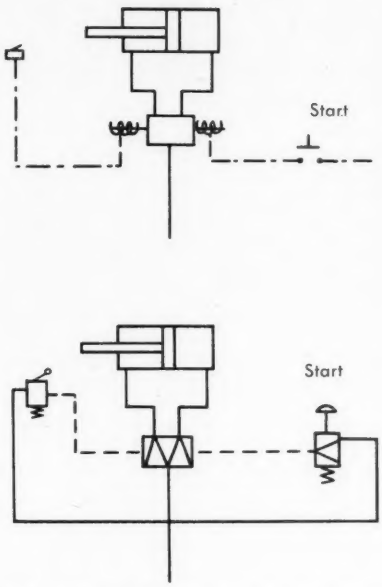

Figure 5—Automatic control circuits—top: electro-hydraulic; bottom: all-fluid power.

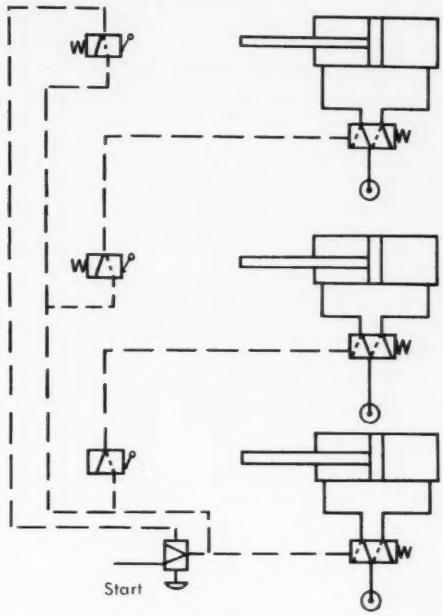

Figure 6—Series of cylinders operating in sequence —ideal for screw machine operation.

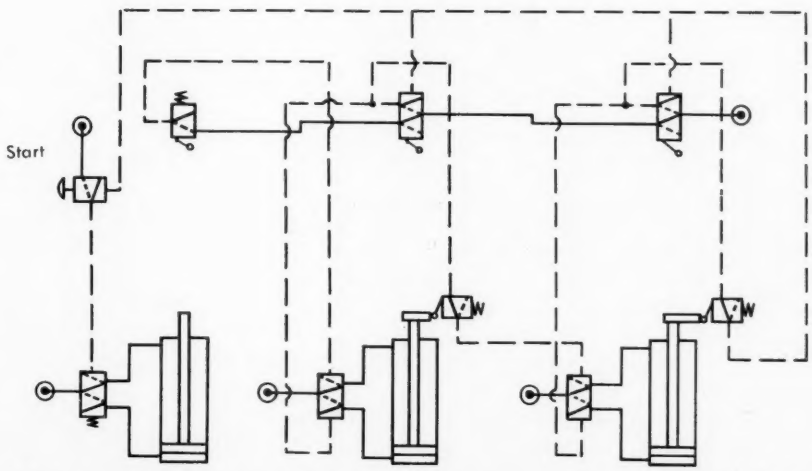

Figure 7—Automatic control circuit where clamping operation is maintained while tools advance and retract in sequence.

It's the component that counts . . .

From A (for accumulator) to V (for valve), here is a glossary of fluid power components, including descriptions and applications

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For most engineers specifying a fluid power system involves little or no original detail work on the design of the components. The basic procedure involves merely the development of the circuit and the selection of the proper components.

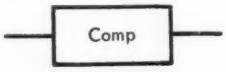
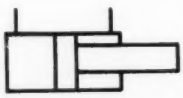
However, let us not be too easily deceived. The selection of the proper components is as important, and as technical, a decision as most designers will ever be called upon to make. The wrong valve, for instance, in a given circuit, could create nothing but chaos. And there are dozens of valve combinations to choose from.

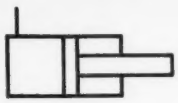
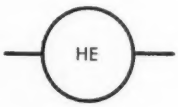
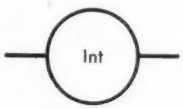
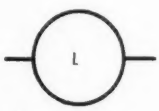
As a guide to the average design engineer in industry, we have compiled the following list of fluid power components. Not all of them have been listed, as space is limited.

Three important details have been included for each component. The JIC symbols are the drafting symbols agreed upon by the fluid power industry for all circuit diagrams. In some cases we have had to give only a sample symbol, since there is no one standard.

The description is basic only. There are many minor — and major — variations between the various manufacturers, and it is necessary to make reference to catalogues for the specific details. Again under the applications heading we have only been able to generalize. There are many other special applications for most of the components mentioned.

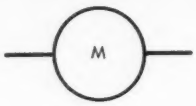
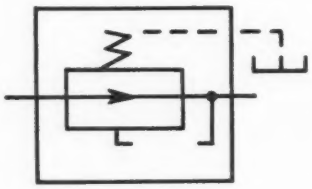
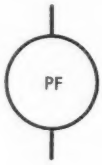
"It's the component that counts" may be a rather strong way to get home our message. But it is definitely not far from the truth. In case of difficulty, your parts supplier stands ready and willing to assist. Make sure you have the right component the first time.

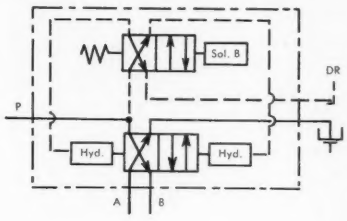
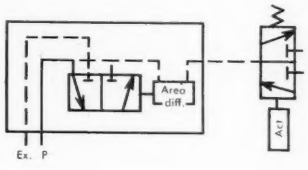
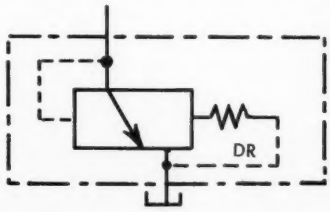
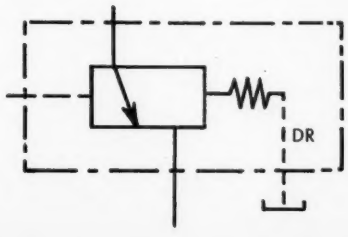
Component	JIC Symbol	Description	Application
ACCUMULATOR Hydraulic		Accumulators store pressurized fluid for a time when an application neds an additional supply or pressure in a hurry.	Accumulators provide a storage for extra power, act as pressure compensators or shock absorber and especially where force is required for a short movement.
ACTUATOR Rotary, air & hydraulic		Usually a vane type mechanism which rotates or turns less than one revolution.	Many common and ingenious applications include turning valves, agitating liquids, indexing rotary tables, moving conveyor segments, bending tubing, etc.
COMPRESSOR Air		Simply a pump to provide compressed air.	Compressors provide the supply of compressed air which operates the pneumatic devices.
CYLINDER Double acting, air & hydraulic		Double acting cylinders advance and retract by fluid power.	Double acting cylinders are by far the most common and are used on all applications where speed and power are required for both stroke movements.

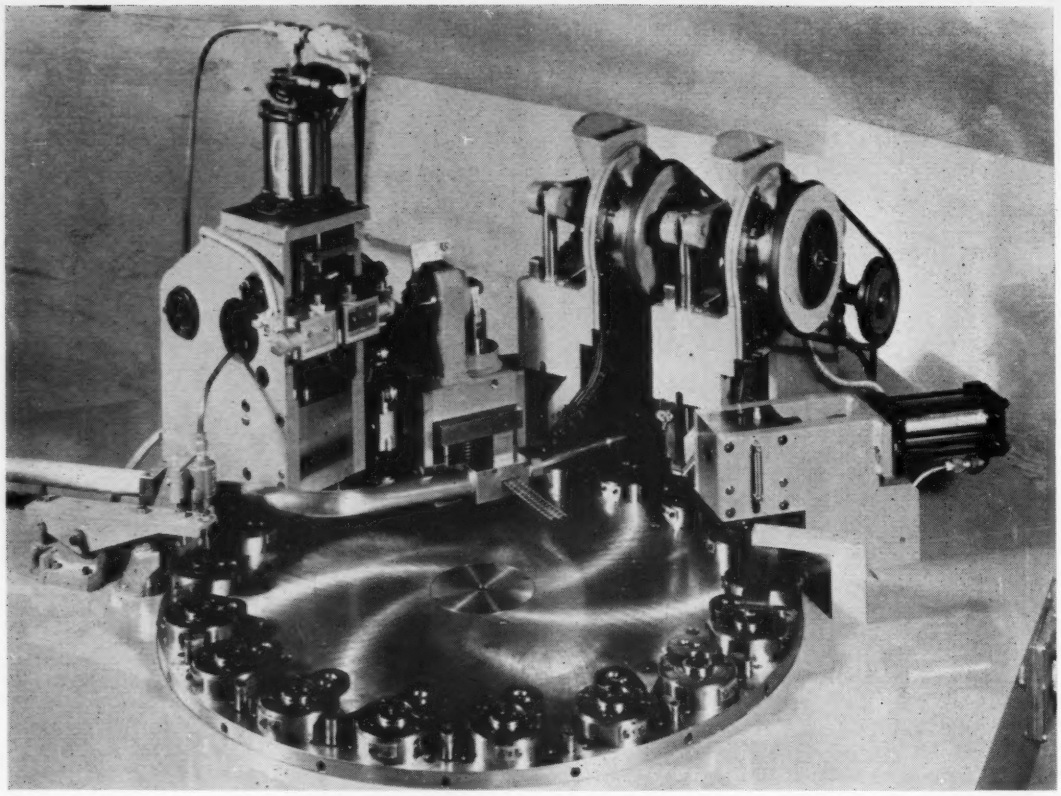
Component	JIC Symbol	Description	Application
CYLINDER Single acting, air & hydraulic		Single acting cylinders use fluid power to operate a cylinder in only one direction and use a spring or mechanical means for the return stroke movement.	Usually short stroke movements, such as clamping parts.
FILTER Air & hydraulic		Usually constructed of porous material such as metal screens, ceramics or other material to remove contaminates from the fluid. In the case of hydraulics, a magnetic plug is sometimes used. A diverter to impart a centrifugal force to the fluid or an expansion chamfer to precipitate foreign bodies is usually incorporated.	All fluid power components operate more efficiently if the operating medium is free from contamination and foreign bodies. Seals may be cut and a consequent leakage occur, cylinder walls or valve walls may be scored, or valves physically restricted from closing, all from foreign matter in the fluid. The maintenance is usually very high in unfiltered fluid power circuits.
HEAT EXCHANGER Hydraulic		A radiator type of device where water, air or oil passes through a shell or tubes to dissipate heat from the pressurized "Working" oil.	Hydraulic systems are robbed of efficiency when the oil gets too warm. One horsepower is equivalent to 42.5 Btu per min. Therefore, when tank capacity and baffle design are too small to hold oil temperature to working limits, heat exchangers may be used.
INTENSIFIER Air & hydraulic		An intensifier is used to compound the work force developed to a point greater than would be possible using the hydraulic pump or air compressor alone. Physical size is a consideration also where forces are high and space at a premium.	The ratio by which the force is being compounded restricts the stroke length, i.e. if the ratio is 10 to 1, 10 volumes of fluid are needed to get 1 volume of intensified pressure. Use is only on an intermittent basis; however extremely high forces are practical.
LUBRICATOR Air & hydraulic		Oil is atomized or fogged after it rises from a reservoir by capillary attraction and pressure drop through a venturi breaks it into minute particles.	Sliding parts require lubrication for longer life and ease of operation. Valves and cylinders are no exception. The easiest and best method is to atomize the oil in the air line.
MANIFOLD Air & hydraulic		Manifolds are a convenient method of mounting a number of valves on a single housing. Manifolds may be drilled or cored for passages to admit high pressure fluids, exhaust or drain, etc. and thus minimize piping requirements. Manifolds reduce installation time and "down" time for repairs and simplify servicing.	Usually where a number of valves of similar function are required on one piece of equipment. Makes design work easier from the standpoint of elimination of piping and unnecessary duplication.

continued ▶

It's the component that counts . . . *continued*

Component	JIC Symbol	Description	Application
MOTOR Air & hydraulic		Usually a vaned type "pump" device where air supplied to the unit produces a rotary movement.	Many applications requiring a rotary motion (as with an electric motor) and particularly where variable-speed is a requirement.
PRESSURE REGULATOR Air & hydraulic		The regulator usually works with variable spring tension being applied to one side of a diaphragm. When downstream pressure is reduced, the valve opens allowing high pressure to replace used fluid and keep pressure constant.	Most fluid power circuits require regulation to conserve amount of fluid required in the case of compressible gases and to control developed force.
PUMP Hydraulic		Several common types: Gear Pump—Two gears rotate and force the oil either between the teeth or externally between the teeth and housing to the system. Vane Pump—Works similar to a turbine with blades attached to a rotor. Piston Pump — Pressure is developed by reciprocating piston movements with suction and discharge valves. Axial Piston Pump — Consists of a drive shaft to rotate the pistons, a cylinder block to house the pistons and a stationary valving surface facing the cylinder block bores which ports the inlet and discharge flow.	To generate hydraulic oil pressure and deliver the oil to the system.
SERVO CONTROL Air & hydraulic		The basic concept of servo control is to magnify a slight electrical or other impulse, so that a fluid valve may be actuated to operate a primary power actuator. Servo control is rapidly approaching the commonplace in machine design. However, today, servo controls are found only in very special applications of fluid power.	Anywhere in a circuit, either fluid or electrical, where a signal of low magnitude must be amplified to perform a useful function. Sensing devices for sizes or machine control are an excellent example.
VALVE Diaphragm, air & hydraulic		Actuated by a diaphragm either single or double. Single units have a spring return to normal position. They develop a strong force from a low pressure signal to allow the valve to shift when high pressure fluids are used in the main valve.	Any application requiring a low pressure signal to actuate a fluid of a different type or a high pressure. They are very positive in action.

Component	JIC Symbol	Description	Application
VALVE Flow control, air & hydraulic		Valves with an orifice which may be manually or automatically set to adjust the flow of oil or air.	Flow control valves offer a convenient device to adjust speed of cylinders and other fluid power devices.
VALVE Mechanical, air & hydraulic		These valves are available in all series and with a variety of actuators, levers, foot, cam, button, clevis, etc.	Where a mechanical linkage or a manual function can be utilized to initiate the valve sequence.
VALVE Pilot, air & hydraulic		Pilot valves are actuated by pilot pressure being introduced to one end of a spool. In the case of single pilot valves, there is an area differential between the sides of the spool to return the valve when pilot pressure is released. In double pilot valves both spool ends are the same area. Pilots may be remote or integral.	In hazardous areas the main valve can be located in the danger area and the pilot actuators removed to a non-hazardous location. Can be used where sequencing is necessary with a signal from another valve. Used where different fluids are employed in the same circuit, one for pilot, one for main, or where two pressures are required.
VALVE Poppet, air		Poppet type valves are of a type utilizing exhaust air to create a pressure in balance with the valve, causing the spool to shift toward the low pressure side.	Hazardous locations where electric operation is not desirable. These valves are also available with solenoid poppet controls. They have an extremely rapid response and they are preferred where a low elapsed time cycle is required.
VALVE Relief, air & hydraulic		Relief valves are spring loaded under variable tension to permit pressure of a calculated force to be present in a circuit, when this pressure is exceeded the valve opens allowing the fluid to relieve the excess of pressure.	Used on pumps and compressors to ensure safety, and in filter power circuits to prevent damage to components.
VALVE Sequence, air & hydraulic		Usually spring loaded in the closed position until control pressure overcomes spring tension allowing control pressure to pass through the valve.	These valves are used when a prior operation, such as clamping, must reach full pressure before another function takes place. They are used to ensure a series of operations will proceed in the proper sequence.



Specially designed to assemble motors for spring shade rollers, this machine incorporates a rotary table, three air motors, six cylinders and nine valves.

Do you know your cylinders and valves?

This knowledge is the foundation for more fluid power applications

Donald B. Guy, P.Eng.
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Fluid power today is playing a very vital role in the field of tool and machine design. By the use of fluid power cylinders, triggered by valves or electrical switches, complex new machines are easily designed and automatically controlled. Outdated machines are converted to operate with modern production standards and many times specially tooled to outproduce the best available equipment.

Fluid power has found a lasting place in the field of automation, both in the gigantic automatic machines of the industrial greats and in the small shop where automation is on a do-it-yourself basis.

Cylinders

The common cylinder, the muscle of the fluid power system, is simply a device to exert a "push-pull" force.

Double acting cylinders both advance and retract by fluid power. This arrangement gives them the advantage of practically full force for both pushing and pulling.

Single acting cylinders use fluid power in only one direction and use a spring or mechanical means for the return stroke movement. Single acting cylinders are widely used in small diameters and only where the spring-return needs to perform little or no work.

How to pick the right cylinder

There are six important factors to consider in choosing an air cylinder. These are:

1. Force required.
When a direct force is required, it is simple to choose the correct diameter cylinder. One has to consider only the available air supply and the total force required and,

from these two factors, calculate the diameter. However, a reasonable overload factor must be included to allow for fluctuations in air pressure, heavier loading than was anticipated, or other contingency. We usually take 80% as the overload factor. Thus:

Force (lbs.) = Available air supply (psi) $\times$ .80 $\times$ area in square inches

or $$F = P \times .80 \times A$$

now, $$A = \pi \frac{D^2}{4}$$

therefore, $$F = .8P \times \frac{\pi D^2}{4}$$

$$D^2 = \frac{F}{.2 P \pi}$$

$$D = \sqrt{\frac{F}{.628P}}$$

Manufacturers offer a wide choice in cylinder diameters. The most common sizes are: 1¼, 1⅞, 2, 2½, 3, 3⅝, 4, 4½, 6 and 8.

There are many other sizes available ranging from ¼ in. diameter to 20 in. diameter, but the above are the most popular.

2. Mountings available

Most air cylinder manufacturers offer the following mounting styles: Foot or side mount, pivot or clevis mount, front flange mount, threaded nose mount, trunnion mount, double end, and rear flange.

There are no standard dimensions for any air cylinders and manufacturers' catalogues must be referred to for details and specifications.

3. Available air supply

The higher the pressure of the available air, the smaller the diameter cylinder required to provide the force. Most air systems deliver 80-120 psi and cylinder diameters may generally be calculated on this pressure range. However, for abnormally high or low pressures, adjustments should be made accordingly.

4. Stroke movement

Most cylinder manufacturers offer a wide choice of standard stroke lengths. The smaller diameter cylinders are usually available in shorter strokes and the larger diameters in longer standard strokes. As a general rule, standard strokes are listed up to 18 inches. Made-to-order or special strokes can be made, to the practical limits of the diameter of tubing and the diameter of piston rod to be used. Severe deflections of the piston rod or cylinder will cause excess wear on seals and packings.

We suggest that manufacturers' catalogues be consulted for standard stroke lengths and limitations for long stroke cylinders to ensure a more economical and properly designed application.

5. Speed of operation

There are many cylinder applications where speed of operation is a critical factor. When such a condition exists, the only solution is to review the application and use experiment or past experience to determine the proper cylinder specification. This method may not seem very scientific, but any calculation of speed is too complex and undependable to rely on.

Speed of a cylinder depends on so many variables that there cannot be any safe formula. Any such formula would have to consider: size of cylinder, fluid pressure, fluid volume, lubrication, cylinder construction, valving, load, tolerance of cylinder parts.

6. Type of applications

Cylinder applications generally fall into three groups:

1. Straight pushing or pulling.
2. Controlled pushing or pulling, with precise speed.
3. Impacts.

The straight pushing or pulling type of application usually covers movements to operate foot pedals, hand levers, clamps or operations to move a component part.

The controlled movement group covers applications where a more precise rate of movement is required, such as the movement of a milling table or saw blade. Many of these applications require a dashpot or hydrocheck when the movement is extremely slow or the speed must be carefully timed.

The third group is where a quick or impact movement is needed to produce a hammer blow effect. These cover such applications as stamping, staking, punching, etc. These operations can be accomplished by a small diameter cylinder, weighting the piston rod and using valving that supplies a good volume of air, together with a fast exhaust.

To get the greatest effect from the cylinders used in impact type of operations, it is advisable to install the cylinders vertically so that the force of gravity will also help to increase the blow. The impact may also be improved by adding piston rod weight, using a longer stroke length, using a faster or smaller diameter cylinder, or using larger port valves. It is well to keep in mind that the cylinder is not providing the ultimate force; the work performed is the weight on the piston rod multiplied by the speed of travel. The more the weight and the faster the speed, the greater the impact.

Choosing the right valve

The valve is the heart of the fluid power system. It is the valve that directs the fluid to the cylinder and sets up a sequence when signalled by a switch or other control. By opening or closing valves, we start movement, we apply force and we emit the fluid medium.

Before we consider any valving, it might be well to come to an understanding of 2-3-4 way valving. This point is confusing and even within the fluid power industry there are different definitions of the terms. Generally, the pneumatic manufacturers count the number of valve ports for designation, and the hydraulic manufacturers count the number of flow directions for designation. Therefore, may we caution that any consideration or discussion of valving must first come to a common denominator of what is meant by 2-3 or 4 way valves. To simplify our study, only one set of definitions will be described, namely those used by the pneumatic industry.

2-way valves

These usually supply only a flow of air or fluid in one direction. The common water tap is thus a two way valve, since it has two ports, one an intake and the other an output.

3-way valves

Three way valves normally provide a flow of fluid from the supply through the valve to a cylinder (for example)

continued ▶

and when the flow is closed (changing the valve from "on" to "off"), the cylinder fluid is released back through the valve to an exhaust or drain. The 3 way valve is most commonly used to operate a single action cylinder.

4-way valves

The four way valve provides the means of applying fluid to either end of a double action cylinder. When the fluid is applied to one end, the opposite end is exhausted or drained back through the valve at the same time.

The most common use of mechanical valving is for operation of single cylinders and where no tie-in is required with other functions of the equipment. For example, pressing bushings into a casting or using an air cylinder for clamping. The common mechanical valves usually have the same basic body but may be equipped with a variety of activators to conveniently apply the valve.

Basic mechanical valves are all direct thrust, or work directly with hand lever, foot lever, etc.

Pilot operated valves

A pilot operated valve arrangement consists of a larger valve operated by a flow of air from a small or pilot valve. The pilot operated valve has the advantage of being operated quickly with little actuating force. It may be either close or remote, even though the main valve body may be large. In fact, valves of 1 in. or more would be physically very difficult to operate by direct thrust.

When the pilot is mounted remotely, only a small diameter fluid line is required from the pilot to the main valve. This saves fluid and operates the main valve faster than having full ported fluid lines, as when basic valves are used.

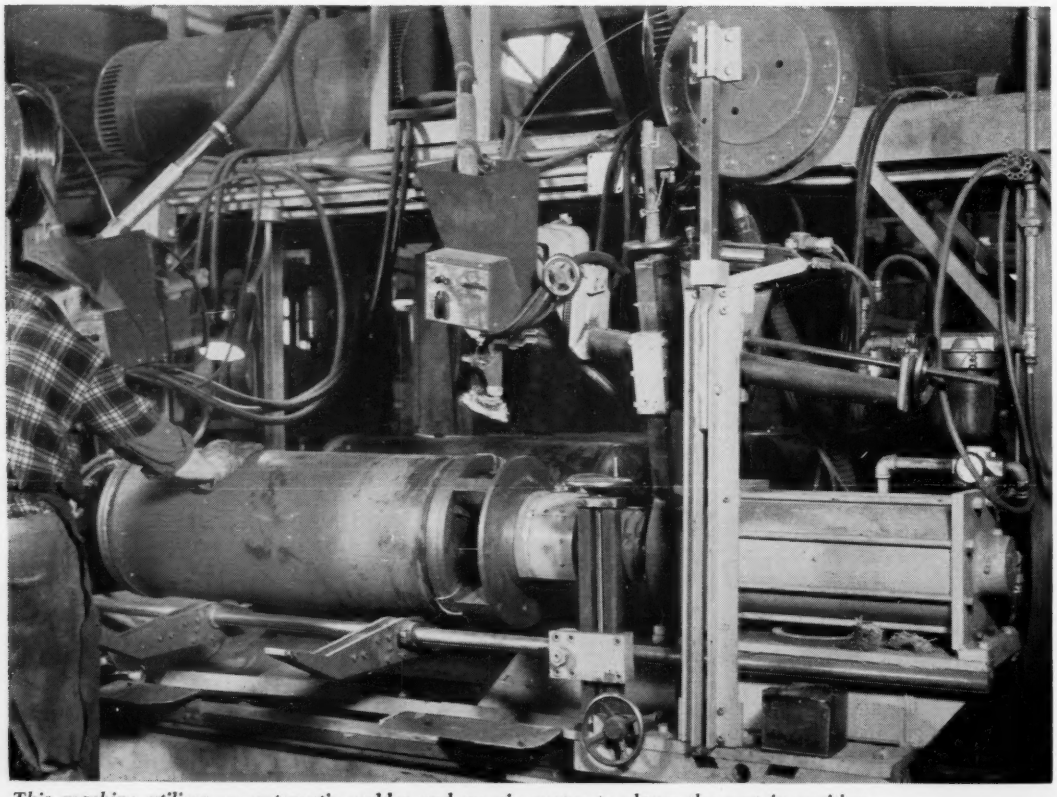
The fluid injected into the main valve body pushes against the spool and makes the shift. Spools, similar to cylinders, may be returned by springs or by fluid on the opposite end. Thus, the valve is designated as a single pilot or double pilot valve.

Poppet valves

Whereas pilot valves direct fluid to a main valve body to actuate the valve, poppet valves exhaust or drain the fluid from one side of the main valve. Fluid pressure is normally on both sides of the spool and by releasing the fluid pressure on one side, the valve shifts. Because poppets usually exhaust air or drain fluid in one direction and only require an "on" and "off" action, they are always 2-way valves.

There are endless variations of the pilot and poppet type of valving. The main valve spool may be air actuated in both directions or may be spring loaded on one side. Pilots or poppets may be either mechanical or electrical. High pressure hydraulic flow may be controlled by air operated pilots and likewise steam, gases and other media may be controlled.

Knowledge of the air cylinder and valving lays an excellent basis for further applications and development of the dynamic world of fluid power. ★



This machine utilizes an automatic welder and an air motor to clamp the part in position.

Designer's chart for hydraulic systems

Causes of failure outlined; many due to wrong fluid being used

Hydraulic fluid is as much a component of a hydraulic system as are the motors, pumps, valves or control devices. As such, it must be given the same amount of consideration as the others when assessing the overall performance of a system.

The function played by the fluid may be approached from two ways: the system performance and the system life. The performance is generally affected by those fluid characteristics which affect fluid flow and mechanical properties; the life of the system is influenced as the fluid affects the life of the components and by the useful life of the fluid itself.

Effects on performance

Viscosity, density, compressibility, vapor pressure, specific heat, air solubility and thermal conductivity are the main fluid properties which affect the system performance.

Viscosity and density are primarily the controlling properties in the flow of the fluid. They control power losses in the system due to flow, efficiency of motors and pumps, and leakages in valves and joints.

Compressibility is the controlling factor in the use of accumulators in the circuits. It also affects the operation of cylinders and is associated with problems in pressure and pulsation.

When it is impossible to get pumps to fill properly and to deliver their rated flow, the culprit is often vapor pressure. Gas solubility may also be involved. These factors must also be considered when problems of cavitation or erosion occur.

Specific heat and thermal conductivity are the main factors affecting heat buildup and rejection.

Effects on system life

Evaluating the effect of a hydraulic fluid on the life of a hydraulic system is another case of the chicken and the egg — which comes first? There is no doubt that the system life is directly affected by the properties of the chosen fluid, but to what extent is a real poser.

The fluid is certainly affected by the condition of the components; the components, in turn, are affected by the fluid. Measuring or separating these two interrelated effects is almost impossible.

System life has many different angles to be considered. These include corrosion, deterioration of parts by contact with the fluid, lubrication and wear.

Except where rusting occurs because of the fluid or exists as a contaminant in the fluid, corrosion is generally negligible with most good hydraulic fluids. Deterioration of the seals, paint and plastic parts in contact with the fluid is often a problem.

Does deterioration affect usefulness?

Deterioration of a hydraulic fluid will often cause the fluid to be altered to such an extent that the fluid is no longer usable for the application.

When fluids are used at temperatures above those for which they have been designed, they will suffer thermal decomposition. This generally results in the production of volatile material and a lowering of viscosity. Even certain so-called high temperature fluids can be ruined in this manner.

Combining with the oxygen from the air usually causes the buildup of gums, resins, acids and the like. The deleterious effect of these on the usefulness of the fluid is beyond question.

Certain types of hydraulic fluids react with water or other cleaning solvents such as carbon tetrachloride. This action often causes the fluid characteristics to be radically altered.

Selecting the fluid

When one considers the haphazard manner in which many hydraulic fluids are selected, it is amazing that there are not more failures due to misapplication. Selecting a fluid calls for careful consideration of all the fluid characteristics, together with the design features of the particular components in the system. When it is impossible to obtain the ideal fluid, one that meets every need of the system, then compromises must be made, as with all practical design problems.

In the industrial field, the basic requirement for a hydraulic system is that of a long reliable working life, with as little maintenance downtime as posisble. However, maintenance problems do come up in the best of designs, but not always caused by the particular design. When this happens, the designer is often caused some embarrassment by not being able to put his finger immediately on the cause of the failure.

For the guidance of such designers, we present on the next two pages a checklist of causes of failures in hydraulic systems, together with the appropriate action to be taken. Not all the causes or cures are listed — but the chart will serve as a good guide.

continued ▶

TROUBLE-SHOOTING CHART FOR HYDRAULIC SYSTEMS

CAUSE	WHAT TO DO
NOISY PUMP	
Air leaking into system	Be sure the oil reservoir is filled to normal level and that oil intake is below surface of oil. Check pump packing, pipe and tubing connections, and all other points where air might leak into system. One good way to check a point on the *intake* side suspected of leakage is to pour oil over it. If the pump noise stops, you've found the leak.
Air bubbles in intake oil	If oil level is low or return line to reservoir is installed above oil level, air bubbles will form in oil in the reservoir. Check oil level and return-line position.
Cavitation (the formation of vacuum in a pump when it does not get enough oil)	Check for clogged or restricted intake line, plugged air vent in reservoir. Check strainers in intake line. Oil viscosity may be too high. Check recommendations.
Loose or worn pump parts	Check manufacturer's maintenance instructions first. Tightening every nut in sight may *not* be the way to stop leakage. Look for worn gaskets and packings; replace if necessary. There is usually no way to compensate for wear in a part; it is *always* better to replace it. Oil may be of improper grade or quality. Check recommendations.
Stuck pump vanes, valves, pistons, etc.	Parts may be stuck by metallic chips, bits of lint, etc. If so, disassemble and clean thoroughly. Avoid the use of files, emery cloth, steel hammers, etc., on machined surfaces. Products of oil deterioration such as gums, sludges, varnishes, and lacquers may be cause of sticking. Use solvent to clean parts and dry thoroughly before reassembling. If parts are stuck by corrosion or rust, they will probably have to be replaced. Be sure oil has sufficient resistance to deterioration and provides adequate protection against rusting and corrosion.
Filter or strainer too dirty. Filter too small	Filters and strainers must be kept clean enough to permit adequate flow. Check filter capacity. Be sure that original filter has not been replaced by one of smaller capacity. Use oil of quality high enough to prevent rapid sludge formation.
Pump running too fast	Determine recommended speed. Check pulley and gear sizes. Make sure that no one has installed replacement motor with other than recommended speed.
Pump out of line with driving motor	Check alignment. Misalignment may be caused by temperature variation.
LEAKAGE AROUND PUMP	
Worn Packing	Tighten packing gland or replace packing. Trouble may be caused by abrasives in oil. If you suspect that sort of trouble, make a thorough check of points where abrasives may enter system.
Head of oil on suction line	Usually it is better to have no pressure on the suction side of the pump, although it may be necessary. With more than slight head, leakage may result. If head is not required and components can be rearranged, do so. Otherwise, don't worry about the leakage. Just wipe off the pump periodically, and, if feasible, install a drip pan. Don't let oil leak onto floor!
OVERHEATING	
Oil viscosity too high	Check oil recommendations. If you're not sure of viscosity of oil in system, it may be worth your while to drain the system and install oil of proper viscosity. Unusual temperature conditions may cause oil of proper viscosity for "working temperature" to thicken too much on way to pump. In this case, use of oil with higher viscosity index may cure trouble.
Internal leakage too high	Check for wear and loose packings. Oil viscosity may be too low. Check recommendations. Under unusual working conditions temperature may go high enough to reduce viscosity of recommended oil too much. Proceed with caution if you are tempted to try a higher viscosity oil.
Excessive discharge pressure	If oil viscosity is found to be OK, trouble may be caused by high setting of relief valve. If so, reset.
Oil cooler clogged	On any machine equipped with an oil cooler, it is probable that high temperatures are expected. If temperatures run high normally, they'll go even higher if oil cooler passages are clogged. If you find a clogged cooler, try blowing it out with compressed air. If this won't work, try solvents.
Poorly fitted pump parts	Poorly fittted parts may cause undue friction. Look for signs of excessive friction; be sure all parts are in alignment.

CAUSE	WHAT TO DO
Low oil	If the oil supply is low, less oil will be available to carry away just as much heat. This will cause a rise in oil temperature, especially in machines without oil coolers. Be sure oil's up to level.
PUMP NOT PUMPING	
Pump shaft turning in wrong direction	Shut down immediately. Some types of pumps can turn in either direction without causing damage; others are designed to turn in *one direction only*. Check belts, pulleys, gears, motor connections. Reversed leads on 3-phase motor are commonest cause of wrong rotation.
Intake clogged	Check line from reservoir to pump. Be sure filters and strainers are not clogged.
Low oil level	Be sure oil is up to recommended level in reservoir. Intake line must be below level of oil.
Air leak in intake	If any air at all is going through pump, it will probably be quite noisy. Pour oil over points suspected of leakage; if noise stops, you've found the leak.
Pump shaft speed too low	Some pumps will deliver oil over a wide range of speeds; others must turn at recommended speed to give appreciable flow. Find out first the speed recommended by the manufacturer; then, with a speed counter if possible, check the speed of the pump. If speed is too low, look for trouble in driving motor.
Oil too heavy	If oil is too heavy, some types of pumps cannot pick up prime. You can make a very rough check of viscosity by first getting some oil that is known to have the right viscosity. Then, with both oils at the same temperature, pour a quart of each through a small funnel. The heavier oil will take a noticeably longer time to run through. Oil that is too heavy can do great harm to hydraulic systems. Drain and refill with oil of the right viscosity.
Mechanical trouble (broken shaft, loose coupling, etc.)	Mechanical trouble is often accompanied by a noise that you can locate very easily. If you find it necessary to disassemble, follow the manufacturer's recommendations to the letter.
LOW PRESSURE IN SYSTEM	
Relief valve setting too low	If relief valve setting is too low, oil may flow from pump through relief valve and back to the oil reservoir without reaching point of use. To check relief setting, block discharge line *beyond* relief valve and check line pressure with pressure gauge.
Relief valve stuck open	Look for dirt or sludge in valve. If valve is dirty, disassemble and clean. Stuck valve may be indication that system contains dirty or deteriorated oil. Be sure, therefore, that oil has high enough resistance to deterioration.
Leak in system	Check whole system for leaks. Serious leaks in the open are easy to detect, but leaks often occur in concealed piping. One routine in leak testing is to install pressure gauge in discharge line near pump and then block off circuit progressively. When gauge pressure drops with gauge installed at a given point, leak is between this point and check point just before it.
Broken, worn, or stuck pump parts	Install pressure gauge and block system just beyond relief valve. If no appreciable pressure is developed and relief valve is OK, look for mechanical trouble in pump. Replace worn and broken parts.
Incorrect control valve setting; oil "short-circuited" to reservoir	If open-centre directional control valves are unintentionally set in neutral position, oil will return to reservoir without meeting any appreciable resistance and very little pressure will be developed. Scored control-valve pistons and cylinders can cause this trouble. Replace worn parts.
ERRATIC ACTION	
Valves, pistons, etc., sticking or binding	First, check suspected part for mechanical deficiencies such as misalignment of a shaft, worn bearings, etc. Then look for signs of dirt, oil sludge, varnishes and lacquers caused by oil deterioration. You can make up for mechanical deficiencies by replacing worn parts, but don't forget that these deficiencies are often caused by the use of wrong oil.
Sluggishness when a machine is first started	Sluggishness is often caused by oil that is too thick at starting temperatures. If you can put up with this for a few minutes, oil may thin out enough to give satisfactory operation. But if oil does not thin out or if surrounding temperature remains relatively low, you may have to switch to oil with lower pour point, lighter viscosity, or, perhaps, higher viscosity index. Under severe conditions, immersion heaters are sometimes used.

Chart courtesy of Sun Oil Company

First of a two-part series

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Mathematics of fluid power simplified

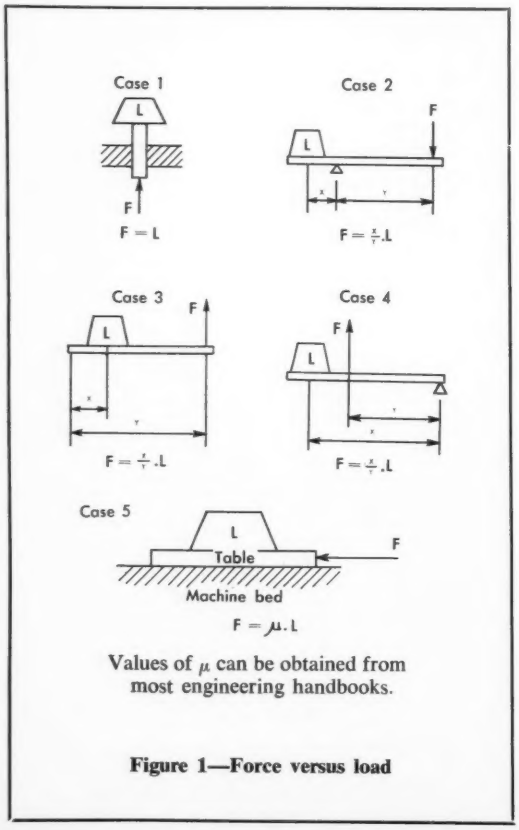
Calculating for fluid power designs is easy — follow this routine

Fluid power, like all other methods of energy conversion has two sides to it, the qualitative and the quantitative. The former deals with the general design of circuits while the latter considers the actual forces involved, sizes of components, velocity of moving parts and a measure of the power needed. The purpose of this article is to present as simply as possible the aspects of hydraulics calling for calculations.

Most of the calculations required are quite simple and straightforward; furthermore, charts are readily available for the asking which allow all the usual computations to be carried out painlessly and without much chance of serious error. However, we cannot rely on always having charts handy, whereas it's an easy matter to jot down a few basic formulae. In the end some of them stick in our memory.

To start with, it's a sound idea to settle for one set of units and stick to these; for example velocity in inches per second, flow in U. S. gallons per minute, and force in pounds. The units used for this discussion are as follows:

F=force (lb.)
P=pressure (lb. per square inch, psi)
A=area (square inches)
D, d=diameter (inches)
Q=flow rate (U. S. gallons per minute, gpm)
V=velocity (inches per second)
T=time (seconds)



Values of μ can be obtained from most engineering handbooks.

Figure 1—Force versus load

Calculating force and pressure

When setting up a fluid power system our first task is to establish the force needed and the pressure to be used in the system. For the sake of completeness, all the usual relationships between load being moved and force needed are treated in figure 1, and we will not repeat them here.

When selecting a system pressure it's a case of economics and availability of components. In general, we should remember that low pressure systems (2,000 psi or under) mean longer life in pumps, valves and cylinder packings due to reduced wear and tear. High pressures (2,000 psi and up) can give trouble due to pipe leaks, cylinder packing failure and overheating of the hydraulic oil. However, the higher system pressures allow for the use of smaller bore cylinders — a cost saving, and this in turn means a smaller capacity pump and reservoir — a further cost saving.

For example, to lift a 100,000-lb. load at 1 inch per sec., we can use a 12-in. bore cylinder with a 30 gpm pump operating at 900 psi or alternatively, a 7-in. bore cylinder with a 10 gpm pump at 2,600 psi.

Calculating cylinder size

With the details of force and pressure established we can compute the cylinder size. To begin with, assume a cylinder bore size and calculate the force it will develop. Alternatively, knowing the force, calculate the cylinder area needed, see figure 2. Remember, too, that a cylinder develops a smaller force when pulling compared to pushing.

Other factors in cylinder selection

It's assumed by many that a standard cylinder with a standard rod, selected from a catalogue, is the be all and end all to cylinder selection. This is not quite the case. The standard cylinder, when loaded in compression, is a column. The longer the stroke becomes, the more attention must be paid to rod diameter to prevent column failure. On still longer strokes, the concept of jack-knifing must be considered.

With horizontal applications, bearing load many cause early breakdown. Cushioning is another device that, when applied to standard lengths, is capable of only so much ability to cushion effectively. We can

now consider two of these factors in our selection of the hydraulic cylinder.

Checking the need for a stop tube

As the cylinder stroke is increased to beyond about 20 inches, certain types of mounting when subjected to push loads, endanger the installation through jack-knifing. With the rod in the fully extended position, the piston and the rod bushing can be too close together for comfort. The remedy is to include a stop tube between the piston and rod end cap to provide the necessary stability (see figure 3). The length of the stop tube needed varies according to what make of cylinder is being considered but generally speaking the length can be calculated using the following formula:

$$\text{Stop tube length} = \frac{\text{c. l.} - 40}{10}$$

where c is a constant obtained from figure 4 and l is the effective column length indicated in the same figure 4. Both factors depend on the style of cylinder mounting. A negative answer indicates that no stop tube is neccessary. Note, too, that stop tubes are not required on front flange mounted, foot mounted or front cap trunnion mounted cylinders. Remember that the addition of a stop tube has the effect of dimensionally pushing out the position of the blank end of the cylinder by a distance equal to the length of the tube. The over-all installation will need checking to see whether this length increase can be accommodated.

Computing piston rod diameter

Hydraulic cylinders are supplied with a choice of rod diameters, the smallest diameter being referred to as a "standard rod". When the cylinder is pushing with its maximum capacity (maximum pressure applied), the "standard rod" diameter will be adequate from the point of view of compressive strength. However, with any stroke above a few inches long the "standard rod" diameter may not be adequate and must be computed from the point of view of column loading.

Basically a cylinder with rod extended is a column and Euler's column formula applies:

$$\frac{F}{A} = \frac{E.\pi^2}{\left(\frac{k.\,l}{\bar{r}}\right)^2}$$

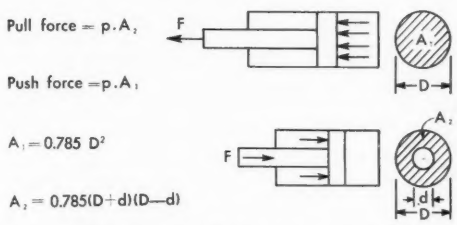


Figure 2—Cylinder area formulae

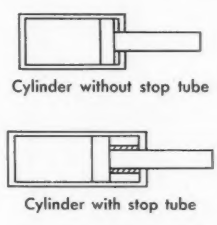


Figure 3—Stop tube application

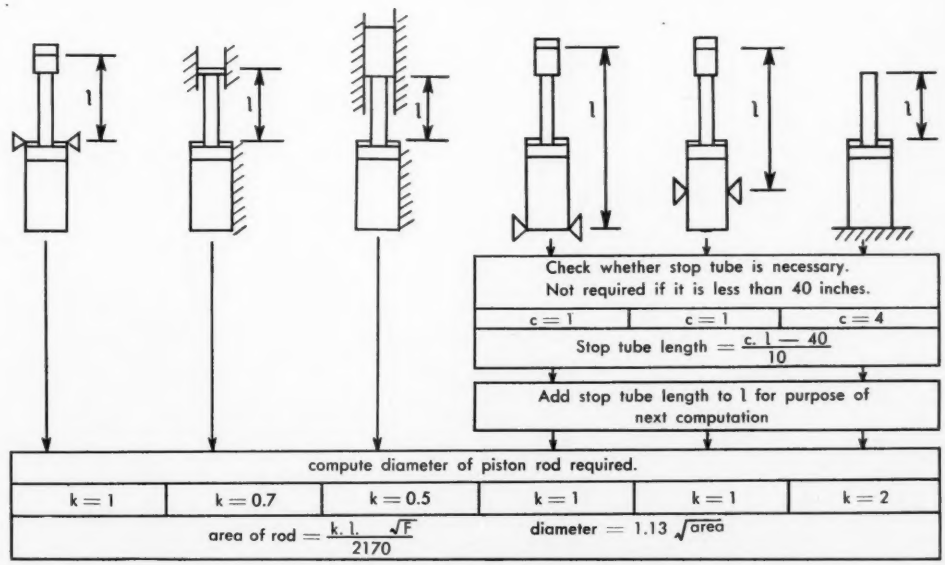


Figure 4—Constants used in cylinder calculations

continued ▶

Mathematics *continued*

When brought to manageable proportions the expression is:

$$\text{Minimum piston rod area} = \frac{\text{k. l.} \sqrt{\text{F}}}{2170}$$

This takes into account a safety factor on the load of 5, and is good for solid piston rods of steel. F is the compressive load, k and l again are as indicated in figure 4. The expression is for rod area, from which diameter is the next simple step.

It can be seen that the diameter of rod required to support a load as given by this formula is not dependent on ultimate or yield strength of the material, therefore hardening the rod will not improve matters.

Should column loading present a serious problem consider the possibility of going to a different mounting having a reduced value for k.

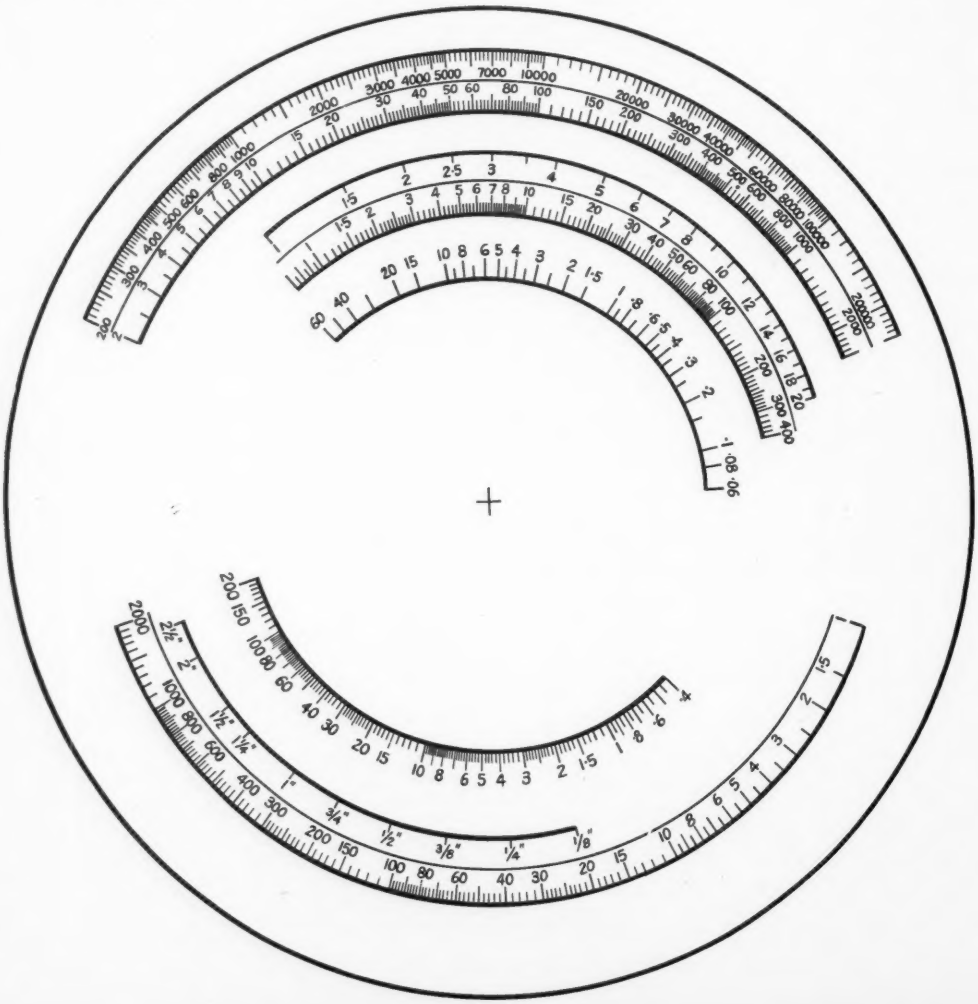
This article will be continued in a future issue of Design Engineering.

Instructions for assembling hydraulics slide rule

Longhand calculations generally take a lot of time and require an extra amount of care. Engineers long ago solved this problem—and lightened their work—by the use of slide rules. Here is a new circular slide rule specially designed for the readers of DE which can provide fast answers to the usual calculation problems associated with hydraulics.

Here's all you have to do to make the slide rule workable. Simply paste the two parts of the rule to stiff card. Good quality Bristol Board is recommended. Cut around the outside heavy outline. Cut out the windows as marked. Attach the circular half behind the rectangular half. A small aluminum rivet will be OK for this—but be sure the two parts are exactly concentric.

To operate—follow the instructions on the face of the slide rule.

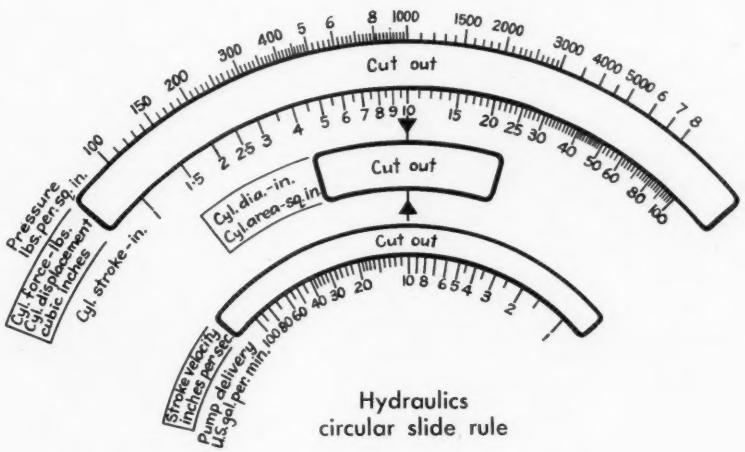


Design Engineering DATA SHEET

Hydraulics slide rule

Set cylinder diameter or area against arrow.
Read cylinder force against pressure.
Read cylinder stroke against cylinder displacement.
Read stroke velocity against pump delivery.

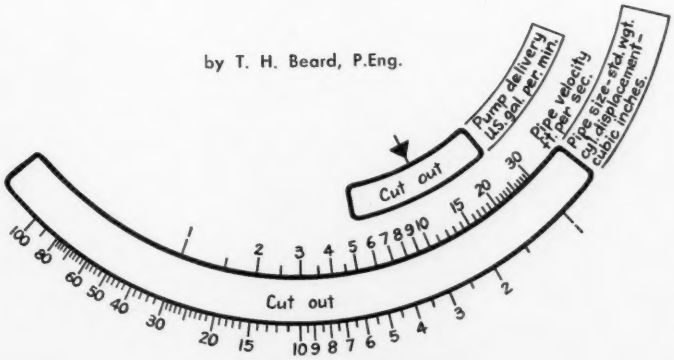
Set pump delivery against arrow.
Read pipe velocity against pipe size.
Read stroke time against cylinder displacement.



Hydraulics
circular slide rule

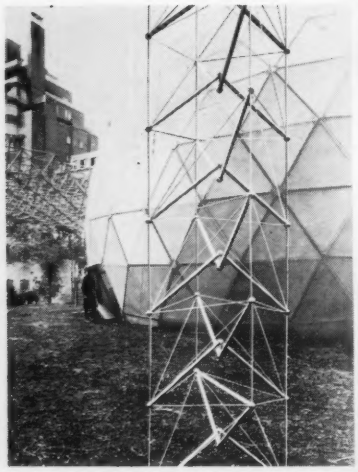
+

by T. H. Beard, P.Eng.

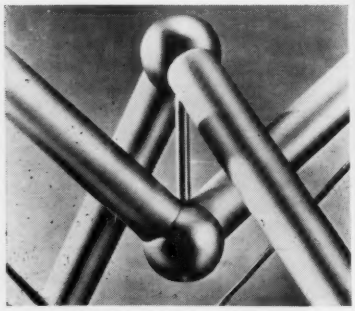


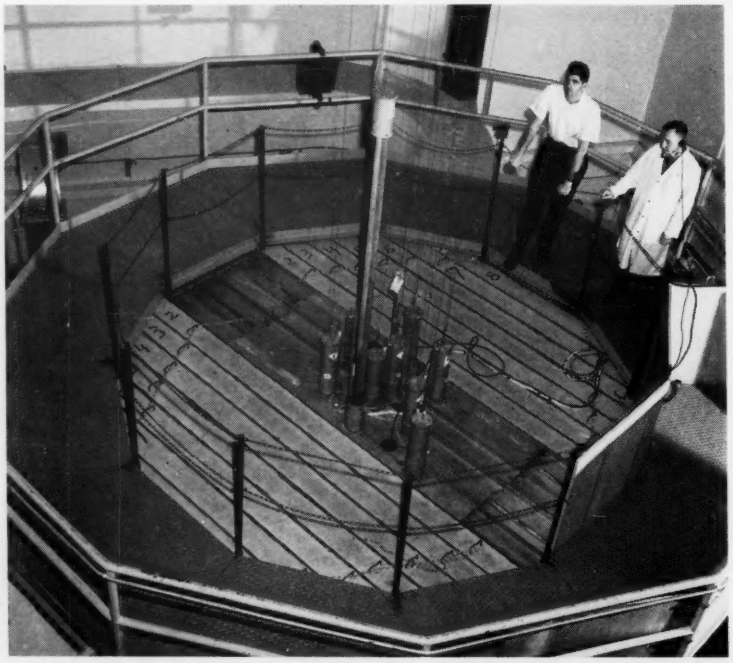
Designews in pictures

Boeing designers working on model planes built to one-tenth scale. Models are used mainly for wind tunnel tests.

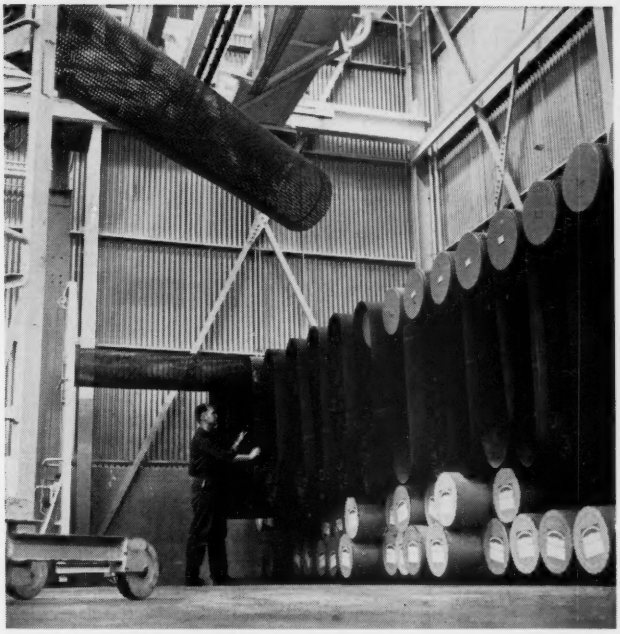


This structure demonstrates the designer's theory that buildings based on the tensile strength of steel can be lighter and stronger. It is 36 feet tall, weighs only 85 pounds. Below: Key element of each truss is high-strength aircraft bolt.

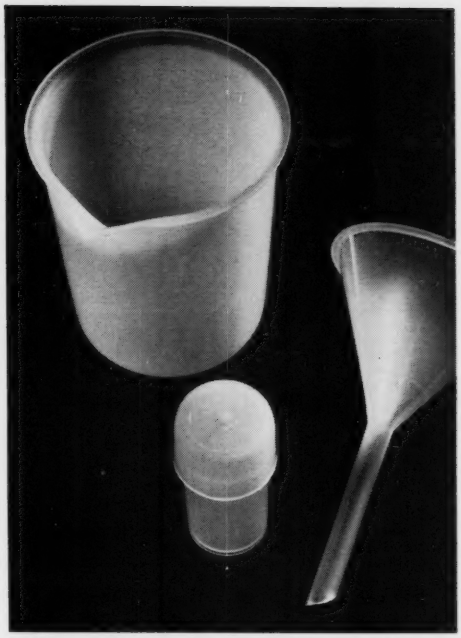




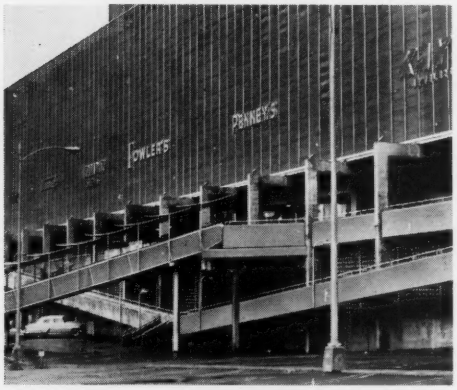
Engineers inspect control and safety rods of a sodium-graphite reactor critical facility at a nuclear laboratory near Los Angeles. Assembly will provide data for other sodium-graphite programs.



Storage racks for abrasive belts prevent damage from wrinkles, mildew and other causes when not in use.

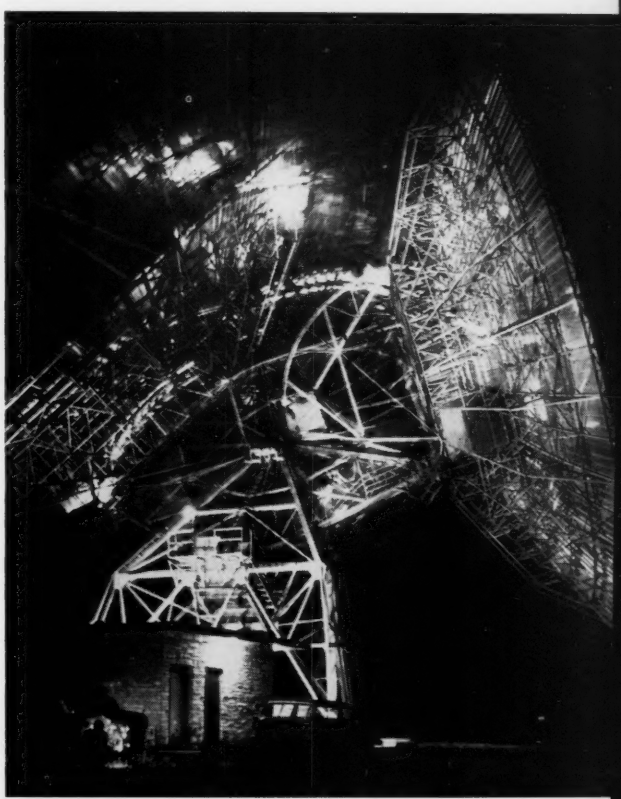


Laboratory ware of polypropylene withstands up to 140 deg. C, can be used under vacuum.

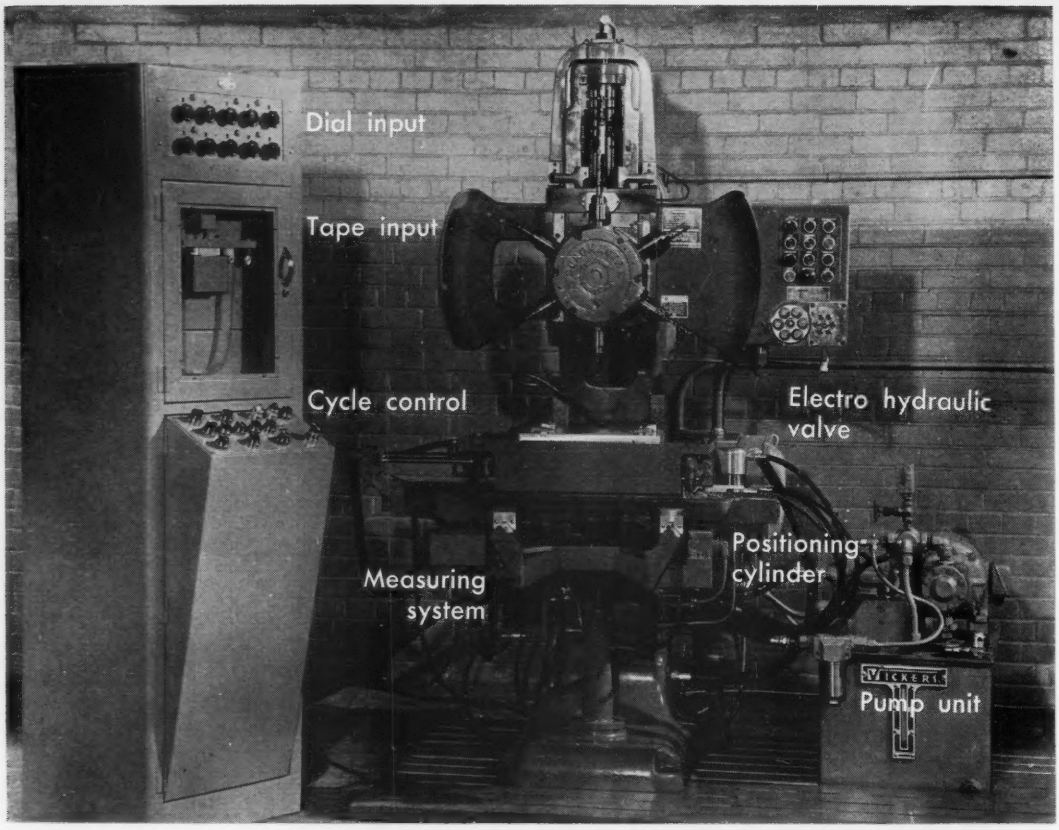


Passenger conveyor system carries shoppers from parking lot to stores in Knoxville, Tenn.

Designed to meet requirements of the spike-heel era, new conveyor exitway has a "floating comb" which pushes out extraneous objects.



Multiple exposure of radio telescope whose axis is parallel to the axis of the earth.



Air and oil combine in machine control

Modern automation process achieved with hydraulic and pneumatics

Peter J. Herzl, P.Eng.
Numerical control development
Sperry Gyroscope Co. of Canada Ltd.
Montreal

Today's numerically controlled positioning systems are capable of programming and directing almost any manufacturing or inspecting process at a cost so attractive that many a control system has paid for itself out of savings within the first three months of its use.

To make the systems even more attractive it has become possible to process the required command information into the form required by these numerical controls with office typists who have received only very limited additional training.

This article will concentrate on describing one particular system, in this case a multispindle drill press, which will illustrate the basic principles of this type of operation. It is important however, to remember that while the system described is a multispindle drilling machine the same control system with only minor modifications can control almost any manufacturing operation.

Systems have common elements

In general all numerical control systems have certain common elements.

(a) The tape reader which reads the command information for the machine.
(b) The measuring system which reads out actual machine position.
(c) A comparison section which compares the command information with the actual positional information as read out by the measuring system.
(d) The positioning system which moves the machine member until the actual dimension information agrees with the command instruction issued by the tape reader.

When the above elements are combined as on the multispindle drill press a fully automatic tape controlled machine cycle is obtained.

The command section

The tape reader used with this particular control utilizes one-inch-wide perforated paper or plastic tapes. While this is by no means the only media that can be used it is the most popular format and has been standardized in the machine tool industry for the control of the less complex positioning systems.

The command information for the machine is carried on the tape in the following manner. The tape has room for eight tracks of holes. For the purposes of this discussion we are only interested in four of these eight tracks. These four tracks can be considered as the number eight track, the number four track, the number two track, and the number one track. A decimal number would be presented in the following manner on such a tape:

Number 1 would be a hole in the number 1 track.
Number 2 would be a hole in the number 2 track.
Number 3 would be a hole in each of the number 2 and 1 tracks, 2 and 1 adding to 3.
Number 4 would be a hole in the number 4 track.
Number 5 would be a hole in each of the number 4 and 1 tracks, again 4 and 1 adding to 5.
Number 6 would be a hole in each of the number 4 and 2 tracks, again 4 and 2 adding to 6, and so on.

Two distinct methods for reading the tape are in general use. The most common method uses a mechanical tape reader which senses the presence or absence of holes in the tape with small mechanical fingers and reads the tape, one line at a time. With such a reader it is necessary to read the information one line at a time and store the information obtained from each line until all the information required for a particular position has been read and the machine has moved into position.

A pneumatic reader

On the Sperry system a specially developed pneumatic reader reads all the information required for one particular position at one time, thus eliminating any intermediate buffer storages. The air system of reading also offers a number of other advantages.

(a) By always blowing air out of the tape any dirt on the tape is blown away and the system becomes relatively immune to its shop environment and is capable of operating trouble free in a normal machine shop.
(b) The air imposes relatively no mechanical wear on the tape and tape life becomes extremely long.
(c) The air cushions the tape during transport and thus increases tape life.
(d) The air automatically pressurizes the cabinet and thus reduces the amount of dirt entering the cabinet.

The tape is read by air blowing through the tape, the presence or absence of the holes being sensed by the pressure difference in a diaphragm chamber caused by the blocking or unblocking of the hole by the tape. The diaphragm unit in turn trips or untrips electrical limit switches. These, in turn, set up the dimensional information in a form which can be compared to the output of the measuring system.

The measuring system

The measuring system must read out in electrical form the actual machine position at all times during the controlled cycle. There are two main types of measuring systems in popular use:

(a) The indirect type of measuring systems which convert the number of turns in an item, such as lead screws, into dimensional information. This type of measuring system builds up inaccuracies from several components such as the inaccuracy in the screw, the inaccuracies in gearing the screw to the electrical measuring device itself, and any backlash which may be present in the system. This accumulation of errors limits the application of this type of system to machines where tolerances of larger than .001 in. are satisfactory. Better accuracy can only be obtained if very special precautions are taken.

(b) In the Sperry system shown on the machine in the accompanying illustration direct, linear, inductive, noncontact measuring devices are used which read out machine position to extremely high accuracies without going through any additional linkages and gearing which may introduce additional error in the system.

When installed, these electrical scales are protected from all normal shop environment and, since there is no physical contact between the scale and slider, the measuring system is subject to very little wear and deterioration in use. The electrical pick-ups used on this control can best be compared to the conventional linear vernier calipers. The measuring scale consists of a printed bifilar coil which is manufactured in discrete length. Additional scales can be placed end to end to build up any reasonable length. The slider corresponds to the usual vernier arrangement. Fine dimension selection is accomplished by simply connecting the electrical input to the correct coil on the vernier.

In addition to this fine measuring system a coarse measuring system is also required to fully describe the location. This can best be likened to reading the scale before reading the vernier to get the coarse positioning. On the machine illustrated a multiturn potentiometer is used for this coarse positioning system.

The type of measuring system on this machine is inherently capable of accuracies up to .0001 in. and repeatability of 10 to 20 millionths of an inch. While this, of course, does not represent complete accuracy, this accuracy is approached on high quality machines which do not in themselves add a great deal of error to that of the measuring system.

The comparison section

The main function of the comparison section is to compare the command obtained from the tape with the actual position read out by the measuring transducer and to obtain a positive or negative comparison varying in amplitude with the error distance from the final end position. This section also provides the power used by the drive system in positioning a member to correct this error.

It is of interest to note the modular construction of this section which allows variation of the system with relatively little redesign and facilitates maintenance.

Hydraulic positioning system

An ideal drive system performs the function of positioning with high accuracy in a minimum time, with high reliability and at low cost.

There are two basic approaches widely used in positioning systems. The first method, generally called an open loop approach, consists of coming in from one direction, slowing down in steps or gradually, and finally stopping when the desired end position is reached. This is generally referred to as an open loop system because after the final stop signal has been given, the control loses all further direction of the machine as it comes to rest. If conditions vary during this final stopping period this variation will show up as a positioning error in the system.

To control this final positioning error it is necessary to select a very low final approach speed and these systems have a tendency to be inherently slow and cumbersome. The system selected by Sperry is a closed

continued ▶

loop system which uses a hydraulic cylinder to directly position the machine member. Control of the hydraulic cylinder is obtained through an electrical hydraulic servo valve which is capable of converting a proportional electrical signal into a proportional hydraulic flow rate.

As can well be expected this electrohydraulic servo valve is the heart of a hydraulic positioning system. While a relatively large number of these valves are available from a number of manufacturers the valve used in this application was specifically developed to meet some of the peculiar requirements in positioning systems.

The qualities aimed for in the development of this servo valve were:

1. A small dead band (the region in which a change in electrical signal will not bring about a change in oil flow).
2. Low hysteresis.
3. Low temperature drift.
4. Good linearity.
5. Reasonable frequency response.

In addition, it became important to be able to operate in normally filtered oil and to be able to maintain all the desirable operating characteristics over long periods of use without service.

In operation the valve receives its command signal from the comparison section. As previously mentioned this is a proportional signal. As the machine approaches its desired location and the error distance between the actual and desired location decreases the electrical signal into the valve decreases. This decreases the oil flow and the table gradually slows down as it nears the end position. When it arrives in position the signal to the valve has become zero and the oil flow stops. Should the table overshoot slightly, which is quite common, the error signal will reverse its polarity, telling the table to move in the opposite direction and the table will return to its desired position.

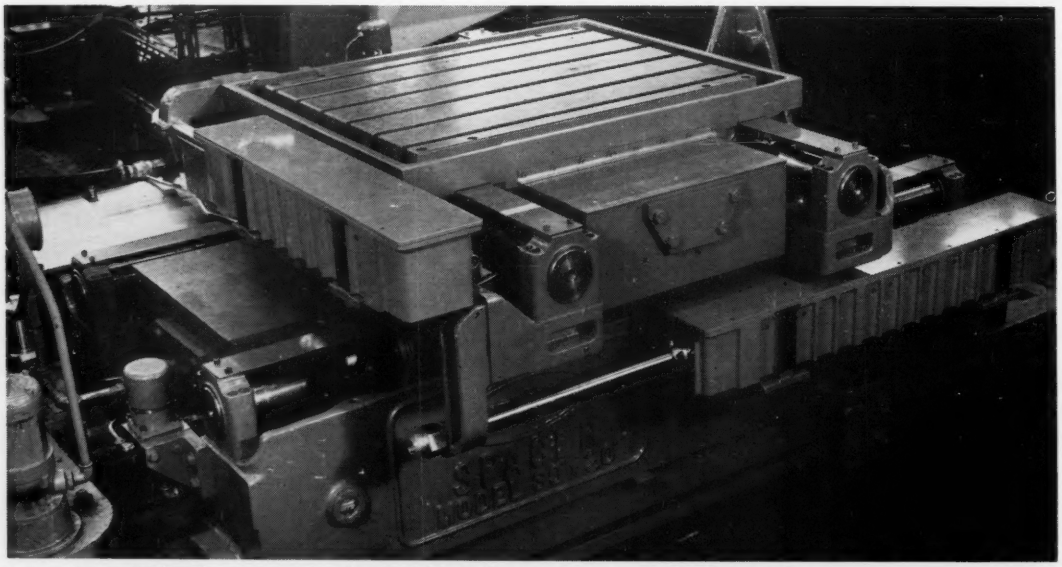
The important thing to note is that in a closed loop system of this type the comparison section is always in control of the table and the valve will be directed to take corrective action until the table has actually arrived at its predetermined position.

While a closed loop system of this type has many advantages it also poses some quite severe engineering problems. If for various reasons the table will not stop at its desired end position the system will continue to hunt and be unstable. It then becomes necessary to analyse the system for its various parameters, such as the transfer functions of all its components, and to see what can be done to stabilize the system and at the same time maintain adequate performance. While this stability problem is common to every closed loop system it can be solved successfully using one of several relatively well known methods of analysis.

To evaluate the possible performance of some of these positioning systems let me quote a few typical examples of the repeatability of position which have been achieved with the type of system illustrated here. On the highest quality jig borers repeatability of better than 20 millionth of an inch have been achieved. On very average machine tools repeatability of better than .0002 have been achieved. It is important to realize that these are repeatability of position figures and not absolute accuracy figures.

The numerically controlled positioning systems which have recently been developed offer a new horizon in the control of our various manufacturing processes and make possible the manufacture of products never before economically feasible. Now for the first time it has become possible for the small lot manufacturers to use fairly automatic processes and to compete on relatively equal terms with manufacturers who are in the mass production business. This makes these controls of particular importance to Canada where our quantities generally cannot compete with that of our large neighbor.

In general the application of numerically controlled positioning systems are only limited by the imagination of the people using and applying them, and together with some of the other new processes now in development are the start of a new industrial revolution which will free us from nearly all monotonous and repetitive tasks in our daily living. ★



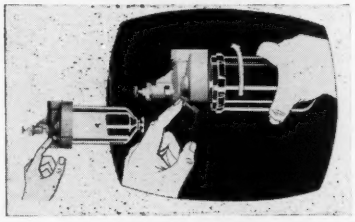
The electro hydraulic servo valve (lower left) is the heart of this hydraulic positioning system.

Pilot control valve

Described as a pneumatic counterpart of an electrical limit switch, a new three-way pilot control valve requires only ⅛ in. of movement and 8 oz of operating pressure. It provides a simpler and more economical layout than an electrical limit switch, and in hazardous locations is said to be useful in eliminating both an explosion-proof electrical limit switch and an explosion-proof solenoid valve. Martonair (Canada) Ltd.

Circle 300 on Reader Service Card

Airline lubricator



A unique quick-change bowl is a feature of a new airline lubricator. The transparent bowl comes off in a second when a locking lever is pressed; nor is it necessary to turn off the air line to do this. The bowl cannot be taken off accidentally because when the bowl is unlocked a valve under the lever is automatically vented, thus relieving all air pressure in the bowl. Wilkerson Corp.

Circle 301 on Reader Service Card

Filter assemblies

A new series of general purpose filter assemblies has pore ratings from two to 100 microns and is available with five different element materials. These materials include woven wire cloth, sintered bronze, pleated resin-impregnated cellulose washers and helically wound resin-impregnated cellulose ribbons. Flow rate and pressure drop ratings are dependent on the filter element materials and the fluids to be filtered. Aviation Electric Ltd.

Circle 302 on Reader Service Card

Power steering kit

The wide variety of power steering units in use today, each with a different length and type of hose line, has made it impracticable to keep a complete replacement inventory of hose lines for all makes of motor and industrial vehicles. A power steering kit solves the problem. The kit contains a handy coil of power steering hose and a variety of reusable fittings to make dependable hydraulic pressure and return lines for many types of power steering units. The only tools required are a wrench and a vise. Aeroquip (Canada) Ltd.

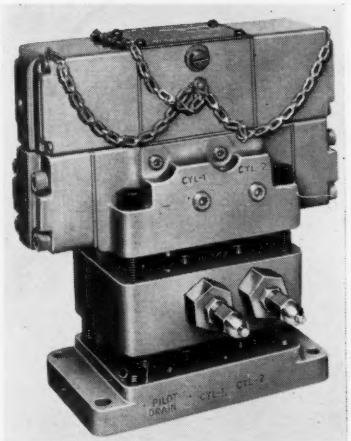
Circle 303 on Reader Service Card

Cylinder mounting

A simple new power cylinder mounting permits speedy installation, is guaranteed not to shift and eliminates the bolting, pinning and/or welding of keys. The mounting is created simply by providing side-mounted cylinders with a flange plate ground to accurate thickness and extending beyond the mounting-side surface of the cylinder. To mount the cylinder, the user merely has to slip the extending portion of the flange plate into a slot milled into the machine's mounting surface, then secure the cylinder by means of the standard mounting provided with the cylinder. With the flange plate extension thus locked solidly in the milled slot, the cylinder cannot shift under the heaviest loads. Miller Fluid Power Division.

Circle 304 on Reader Service Card

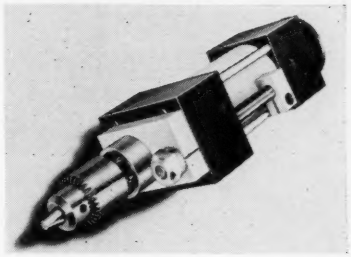
Flow-controlled valve



A new ¾ in. dual flow-control valve with integral check provides for separate, adjustable metering-out of fluid in both cylinder lines. One of a series of valves carrying the name CircuitStak, it is installed by being sandwiched between a ½ in., ¾ in. or 1 in. solenoid-controlled, pilot-operated valve and the sub-plate. The stacking of circuit components in this manner eliminates all interconnecting pipes and permits additions to the circuit without panel alteration or piping. Tem Sales Co. Ltd.

Circle 305 on Reader Service Card

Feed drill unit



The addition of a micrometer stop adjustment to a line of pneumatic drill units permits the operator to adjust easily and hold depth adjustments to .0005 in. A positive lock maintains the setting. The automatic feed drill unit utilizes the normal air pressure available in any shop to provide thrust and motion for drilling, tapping, reaming, spinning, burnishing, milling and other operations on metal, wood or plastic. J. B. Morrison Machinery Co. Ltd.

Circle 306 on Reader Service Card

Hydraulic clamping

Rapid multi-point clamping in any position with equalizing pressure is offered by a new closed circuit hydraulic clamping system using a pump, brackets and cylinders. Up to 120 cylinders can be actuated simultaneously from a single conveniently located hand pump. The system is useful for clamping odd shaped pieces or clamping at awkward locations. Par Industrial Sales Ltd.

Circle 307 on Reader Service Card

Hydraulic pump motor

A new line of hydraulic pump motors is designed with an adapter that allows the pump to be motor-mounted. The motor is available in drip-proof, enclosed or explosion-proof construction. Motors are available in all ratings now supplied in the 182, 184, 213 and 215 frames, nominally one to five hp. Canadian General Electric Co. Ltd.

Circle 308 on Reader Service Card

Continued on page 73

another Plus Value by NOPAK

NOPAK SMASHES DESIGN BARRIER

with world's first SQUARE BARREL CLASS 7 CYLINDER

ACTUAL SIZE 1" DIAM. BY 3" STROKE

ALL SQUARE CONTOUR

The NOPAK Class 7 is the first volume produced cylinder to provide the spectacular advantages of the *complete all-square* design. Aligning the square heads with a square barrel results in four flush sides . . . no humps, no bumps, only clean, smooth lines throughout.

NEW MOUNTING CONCEPT

Only NOPAK's exclusive Square Barrel can give you this unique mounting! Mounting holes can be drilled or tapped directly into cylinder tubing, either longitudinally or at right angles. Cylinder heads can be similarly utilized.

MODERN MATERIALS

Extruded and pressure-cast aluminum (hard anodized) . . . set new standards of performance, durability and light weight.

MOST POWER PER POUND

Aluminum barrel . . . aluminum heads . . . no tie-rods . . . give the Class 7 cylinder the greatest power-weight ratio available.

MINIMUM SPACE

With or without heads, and tie rods eliminated, this Square Barrel cylinder can be built into your machine as an integral unit . . . *in less space than any competitive cylinder.*

VERSATILE, ADAPTABLE

Quick-change mounting attachments in various combinations of foot, flange, clevis or trunnion can be used to meet a wide range of application requirements with *one* basic cylinder.

CLEAN LINES

No tie-rods, no complex head locks, no uneven dirt-catching surfaces . . . make the NOPAK Class 7 Square Barrel a must for food processing, vending machinery, clinical equipment or any place where sanitary conditions or neat appearance are paramount.

STACK COMPACT

Because of their contour, Square Barrel cylinders can be stacked one above the other or mounted side by side in the smallest possible space.

Write for Catalog 107

NOPAK *VALVES and CYLINDERS*

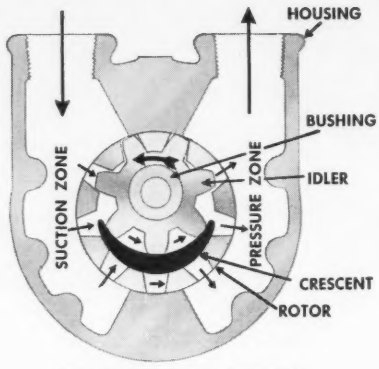
GALLAND-HENNING NOPAK DIVISION

2700 S. 31st St., Milwaukee 46, Wis.
Distributed by Holman Bros., Ltd., Kitchener, Ont.

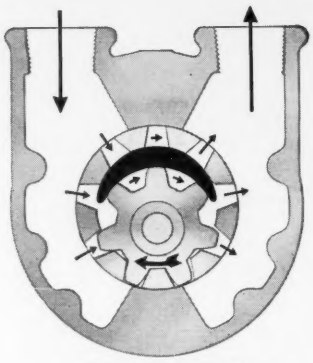
The TUTHILL Internal Gear Pump... and its advantages in reversing applications

by E. H. Schanzlin,
Chief Engr., Tuthill Pump Co.

Extremely high reliability, proven in thousands of applications over a 30 year period, has made Tuthill's internal gear pump an industry standard. The Internal gear construction particularly adapts itself to reversing pump applications as indicated in the sketches at right.



COUNTERCLOCKWISE ROTATION



CLOCKWISE ROTATION

How It Operates

Key elements are the rotor, idler gear and the crescent shaped partition. This crescent shaped partition, shown in heavy black, is cast integral with a moving part called the idler carrier.

In the drawing at left, power is applied in counterclockwise rotation to the rotor and transmitted to the idler gear with which it meshes. The space between the outside diameter of the idler and the rotor is sealed by the crescent. When the pump is started, there is an increase in volume as the teeth come out of mesh. This creates a partial vacuum, drawing the liquid into the pump through the suction port. The liquid fills the spaces between the teeth of the idler and rotor and is carried past the crescent to the pressure side of the pump. When the teeth mesh on the pressure side the liquid is forced from the spaces and out through the discharge port.

When shaft rotation is changed from counterclockwise to clockwise, as in the drawing at right above, the idler carrier, (including the idler gear and crescent) automatically rotates 180° through the suction zone. This changes the directional flow within the pump without changing port positions. The idler carrier rotates in a cover casting fitted with stops so that the crescent can rotate only 180° —always through the suction zone. If rotation were again reversed to counterclockwise, the crescent would swing back to its original position (shown at left above).

No valves required . . . ports remain constant

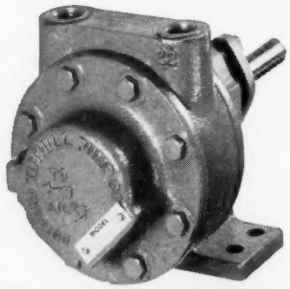
This unique construction permits positive reversing action, without any valves, and with the port positions remaining constant. In addition Tuthill's reversing pumps provide all the other attributes of internal gear construction . . . extremely high reliability, compactness, and high efficiency.

Reversing Pumps with internal gear construction pay particular dividends on applications where the pump must be driven from a reversing shaft or when machinery must be shipped without knowing the ultimate direction of the driving unit.

375 reversing pump models

Tuthill offers a complete selection of over 800 different pumps including 375 different reversing pump models for capacities from ⅓ to 200 GPM; for pressures to 400 PSI; and speeds to 1800 RPM. These include a complete selection of stripped models for incorporation into products. Specially designed housings, shaft extensions, relief valves and many other features can be developed by Tuthill's engineers to meet the requirements of specific applications.

Catalog 105 contains complete information on all Tuthill Reversing Pumps. Write today for your copy.



Typical Tuthill Reversing Pump. Model 2RC has capacity of 5 GPM operating at 100 PSI, 1200 RPM.

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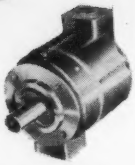
FLUID POWER

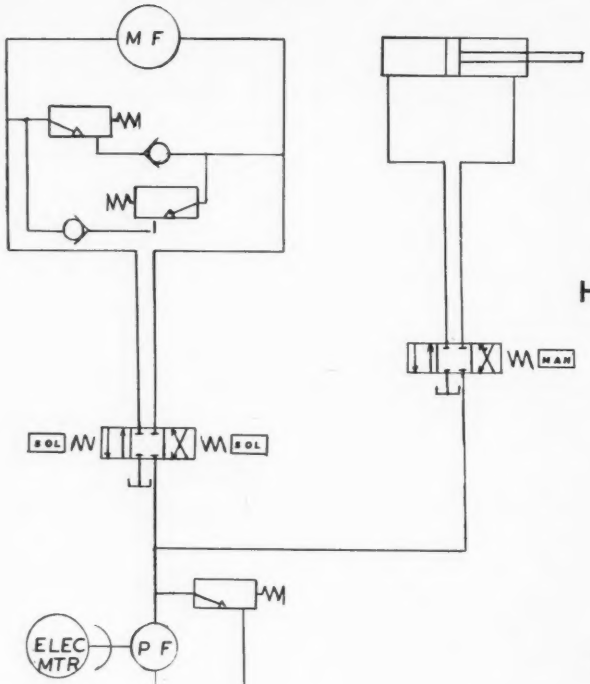
Air Cylinder

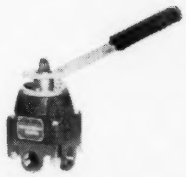


Fluid Motors

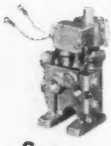
Hydraulic Cylinder

Manual
Air Valve



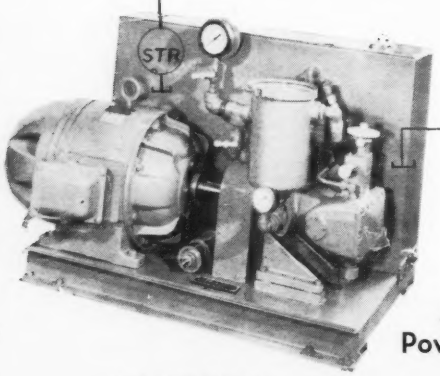


Manual
Hydraulic Valve



Solenoid
Air Valve

Solenoid
Hydraulic Valve



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For further information mark No. 162 on Readers' Service Card

fluid power New/products

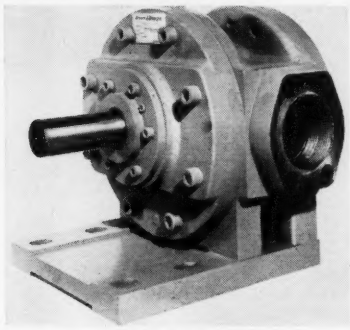
Continued from page 67

Adjusting screw

A threaded adjusting screw, quickly sealed and unsealed, with an ingenious threaded fitting, is the simple device offered for rapid, easy adjustment of cylinder strokes. The adjusting screw is installed in the cap end of the power cylinder; turning it clockwise causes it to enter the cylinder bore, where it acts as a solid "stop" to limit the stroke to the exact length desired. A straight thread fitting seals the adjusting screw against air or oil leakage from the cylinder and keeps the adjusting screws securely locked in position. Miller Fluid Power Division.

Circle 309 on Reader Service Card

Power steering



The first completely integrated power steering systems designed and produced by a single manufacturer eliminate the expense of custom-built components. Built for vehicles with axle loadings of 1,500 to 128,000 pounds, they are available either as integral linkage units or as remote units in which the valve and cylinder are separated. Basis of the design is a single servo valve and high-pressure, double-walled cylinders capable of operating up to 2,000 psi. This high pressure produces about three times the thrust possible with other systems. Vickers-Sperry of Canada Ltd.

Circle 310 on Reader Service Card

Rotary pumps

A new series of rotary pumps incorporates features that make them suitable for greater recirculation and injection service in the gathering of crude oils. Maintenance is made easy through the use of replaceable wear plates, inlets and outlets of the same size, and of flange pipe connections. Brown & Sharpe Manufacturing Co.

Circle 311 on Reader Service Card

Continued on page 74

fluid power New/products

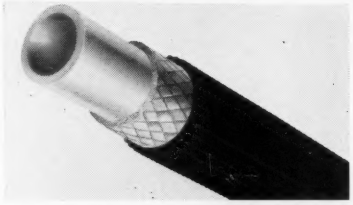
Continued from page 73

Molded packings

A plastic and an elastomer have been compounded to produce a new packing material, highly resistant to abrasion, which can be used in both acid and alkaline applications. Laboratory evaluations have set its tensile strength at over 3,000 psi, indicating its potential for relatively high pressure applications. Its elastic limit is almost 300%. The material seals effectively in air, oil, water and water-based fire-resistant hydraulic media. E. F. Houghton & Co.

Circle 312 on Reader Service Card

Multipurpose hose



A new multi-purpose hose for a variety of industrial applications offers the unusual advantages of combining great physical strength and chemical resistance with relatively light weight and low cost. The central core of the hose is a precision drawn polyamide inner tube, reinforced with a tough, braided covering that provides high burst resistance. Extruded over these components is a durable, abrasion-resistant outer sheath. Eliminating the need for different types of hose for different applications, the new product meets the majority of needs for fluids, grease whips, paint spraying, etc. Samuel Moore & Co.

Circle 313 on Reader Service Card

Metering pump

A pneumatically operated, solenoid-actuated, positive displacement metering pump has been developed with an infinitely adjustable capacity from 0 to 6.44 cc. The pump is for slug feeding of precise quantities of slurries, adhesives, pastes, greases and other viscous liquids and semi-liquids. It is already finding applications in the petroleum and chemical fields; for instance pipeline companies find it the answer to injecting precise amounts of additives to gasoline. Airmatic Valve Inc.

Circle 314 on Reader Service Card

Continued on page 75

New products

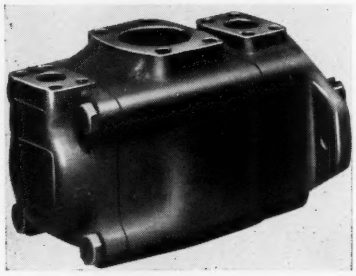
Continued from page 74

Rod packing

A new type of hydraulic or pneumatic rod packing provides a compact, low-cost seal and wiper. It consists of a D-ring for positive sealing action, and double wedge-shaped back-up rings for added stability and protection from extrusion. Pressure produces a double-cam action which extends the wedges fully against the rod and gland O D and closes the rod clearance, preventing extrusion at both the sealing interface and the D-ring heel. Greene, Tweed & Co.

Circle 315 on Reader Service Card

Double pumps



Double pumps have been added to a line of vane type hydraulic pumps to provide a single power source that will supply two separate hydraulic circuits. Combined delivery can be used for greater volume. Design features permit normal operation at 2,000 rpm and 2,000 psi for more work output at less cost per horsepower. Vickers-Sperry of Canada Ltd.

Circle 316 on Reader Service Card

Solenoid valve

A new single solenoid, two position 4-way solenoid valve with ¼ in. orifices is designed to provide positive control of double acting air or hydraulic cylinders. It is used where the automatic return of the valve on power failure is required. A combination of metal to metal and resilient seating provides absolute tight seating on air and metals without grinding or adjustments. The valve can be mounted in any position. Automatic Switch Co.

Circle 317 on Reader Service Card

Electronic pumping

Electronic controls are now available for chemical metering pumps. Three types are available, an all-electric, an electro-hydraulic and a combination electro-pneumatic which uses air for power only. Lapp Insulator Co.

Circle 318 on Reader Service Card

Continued on page 77

New products

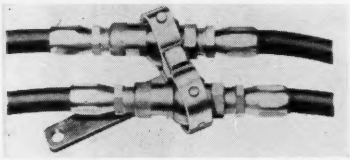
Continued from page 75

Rubber packings

Homogeneous though they possess high tensile strength, a new line of rubber packings is recommended for water, oil or air service and pressures up to 2,000 pounds and temperatures from zero to 212 F. The packings have a durometer hardness of 110 on the "A" scale and have excellent abrasion resistance, low friction drag and excellent shelf life. Made of a new synthetic compound, they cost less than conventional, rubber or fabricated packings. E. F. Houghton & Co. of Canada Ltd.

Circle 319 on Reader Service Card

Coupling and frame



Designed for easy connection and disconnection on all farm hydraulic systems, a new push-pull farm hydraulic coupling seals positively when either connected or disconnected and allows full fluid flow with only negligible pressure drop. A swivel breakaway frame developed for use with the coupling simplifies mounting and alignment problems. Installed in the frame, couplings can swing 30 deg in any direction; this virtually eliminates side thrust as a source of coupling wear and leakage, as the coupling always pulls away exactly parallel to the pull. The coupling is designed to disconnect under minimum stress, thus preventing damage to fluid lines. Aeroquip (Canada) Ltd.

Circle 320 on Reader Service Card

Gasket material

A newly developed high temperature conductive and shielding gasket material extends the temperature range from 500 deg to minus 65 deg F. A silicone rubber with aluminum mesh, it was developed to prevent radio frequency energy from escaping at joints in closed containers with RF emitting apparatus, while at the same time providing positive air and fluid sealing. Its electrical properties provide a necessary conductive material between two metal surfaces to allow the flow of electrical current while restricting or filtering any induced radio frequency. Auburn Manufacturing Co.

Circle 321 on Reader Service Card

Continued on page 78

New products

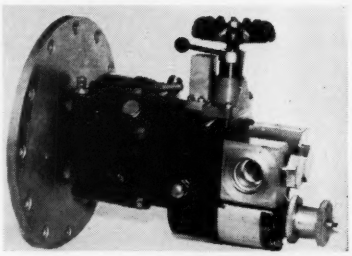
Continued from page 77

Holding valves

A new series of holding valves is specially designed to control pressure in hydraulic circuits. It locks a cylinder or motor when no power is desired; it prevents the load from running ahead of oil supply when the load is being removed; it relieves excessive pressures generated in the cylinder or motor by the load. The valve requires little or no power when a load is being elevated and a minimum of power when a load is lowered. Sarasota Precision Products Inc.

Circle 322 on Reader Service Card

Piston pump



A competitively priced variable volume, pressure compensated, axial piston pump has been developed to meet rigid military specifications. Now in service on Department of Defence equipment, the pump weighs 37 lbs, has 2.43 cub ins/rev, speed 1,200-4,000 rpm, 3,000 or 5,000 psi operation and extremely fast compensator control. Lucas-Rotax Ltd.

Circle 323 on Reader Service Card

Hydraulic cylinders

A number of engineering improvements are featured in a new line of hydraulic cylinders. Among the most important is a newly designed rod bearing which incorporates a metal rod scraper plus a rubber rod wiper. This provides two-fold protection against chips and dirt which tend to enter cylinders and damage them. Carter Controls Inc.

Circle 324 on Reader Service Card

Fluid power pump

A new fluid power pump will have constant volume output in five sizes ranging from three to 24 gpm at 1,200 rpm. It is rated for continuous duty operation at pressures up to 2,000 psi and speeds up to 2,400 rpm. An important feature is the built-in perfect alignment made possible by machining all internal parts from one common reference, the gear centre line. Commercial Shearing & Stamping Co.

Circle 325 on Reader Service Card

Briefs

We note some interesting new engineering wonders: **A self-orienting** synchronous motor whose rotor always synchronizes at the same relative position with respect to the rotating stator field . . . **A new** form of analog computer that can solve problems without mechanical motion of any kind (its makers say it will replace existing computers at lower cost and with increased freedom from failures) . . . **A three-dimensional** closed circuit TV system; its most important application is observing dangerous materials that must be handled remotely . . . **A semi-conductor** alloy which can produce heat or cold from electric power without moving parts . . .

And on a more modest scale, but no doubt equally valuable in their own way, these ideas: **A device** that heats up your car seat on cold mornings (it works off the block heater) . . . **A mechanical** change-maker smart enough to tell a one dollar bill from a five, and a genuine bill or coin from a counterfeit, or from foreign currency . . . **A new type** of paper clip which holds papers or photographs without crimping . . .

Thinking men may give serious thought to cigaret filters, but few people, even the most thoughtful, have any idea of the vast variety of filters used in industry. One company alone makes 3,500 different kinds, designed to filter products ranging from fuels to rouge. There are filters to turn seawater sweet or to cleanse radioactive air in atomic laboratories; filters that can operate at 1,500 degrees Fahrenheit and at 420 degrees below; and filters that can trap a micron (430 million micron particles would be smaller than the period at the end this sentence) . . .

Recent news item reported that a certain top executive in Italy earned the equivalent of $638,000 last year, on which he paid income tax of $92,800, or something less than 15%. Had he been a Canadian, however, his tax liability would have been $452,405, or 71 per cent. Does Mrs. Skofic (Gina to you) know about this? . . .

The U. S. invested $4 billion in research way back in 1955. That investment will add between $100 and $200 billion to the economy in the next two decades, says research firm Arthur D. Little Inc. In Canada research lags far behind the U. S., even on a pro rata basis. Would more research help our disturbing unemployment problem? At least should we conduct research into the

Continued on page 80

Briefs — *continued*

real nature of our unemployment problem, the extent of which appears to be a mystery? . . .

Miscellany: Yet another use for closed-circuit TV: installed near burglar bait like safes and strongrooms, it reveals safe-cracking activities to guards at monitoring screens . . . Someone has come up with an office chair with legs so designed that the castors will never fall out . . . DBS reports that the federal government employs 337,981 persons, which is one out of every 18 in the national labor force; and how many of this third of a million, we wonder, are underpaid engineers? . . .

A machine which can read printed material has been developed for the U. S. Air Force. And if you're wondering why the Air Force can't do its own reading, the answer is that the automatic print reader is needed to feed words into an automatic translator. The translator can translate Russian into English at a speed of 2,100 words, but the human operator can feed only 40 words a minute into the translator. The print reader recognizes 1,000 Russian characters a second. It reads alphabetical characters, numbers and punctuation. Apart from its obvious applications, it is expected to have large-scale commercial potentialities.

Four leading U. S. engineering societies recently honored Frederick D. Braddon, creator of the gyro-compass that guided the Nautilus and Skate under the North Pole, with the Elmer A. Sperry Award for outstanding contributions in the field of transportation. Previous recipients were W. F. Gibbs, who designed he S.S. United States; D. W. Douglas, creator of the D.C. series of aircraft; and the design teams that created the British jet Comet I, the GM diesel-electric locomotive and the Volkswagen car. The four societies: ASME, AIEE, SAE and Society of Naval Architects and Marine Engineers. By a coincidence recipient Braddon is an employee of Sperry Gyroscope, founded by the man for whom the award is named...

Space notes (junior division): Polyethylene film kites will be flying in Canadian skies by the thousand this summer. Texaco dealers are offering them in assembly-kit form as a dealer promotion. Du Pont of Canada says they are guaranteed to fly . . .

Space notes (senior division): A workman in a missile plant lets a delicate part fall gently onto his workbench. The

Continued on page 81

drop is only an inch or two, but the results can be disastrous. Months later a missile can explode off-course in mid-air because of the fall. So ASME was told at a recent seminar. Speaker explained that when instruments fall one to three inches, forces up to 20 times the force of gravity strikes them, with possible disastrous results later . . .

Still on space, technology in this field can help others. **Surgical techniques** in the operating room have been enhanced by an apparatus to refrigerate and preserve human kidneys during surgery; the "kidney cooler" was developed from knowledge gained in providing environmental systems for the Mercury manned satellite and the X-15 space vehicle . . . **And Lockheed** of California, now working on a $500,000 study contract to determine how spacecraft can return to the earth's atmosphere, says some of the information obtained from the study could point toward the properties of new materials and structural arrangements . . .

More miscellany: Cough syrups, vitamins and other oral medications may soon be packaged in aerosol bomb containers for dispensing in controlled doses . . . **An offbeat** service provided by and for engineers is to see imported parts through the customs; service, provided by Wes Park Co., Burlington, Ont. . . . **A Kingston, Ont.,** winner of $1,800 in the Irish Sweep was design engineer Derek Field, who used the money as a down payment on a house . . . **Cost of making** an invention is not tax deductible, says the Income Tax Appeal Board in dismissing the appeal of an Ottawa inventor who claimed a deduction of $3,588 on the $61,000 cost of inventing a highly durable yarn. . . .

Talepiece: American Association for the Advancement of Science is in the forefront among those who want to introduce the metric system to the United States, which, with Canada and Great Britain, is the only major country still using feet and inches, pounds and ounces. But what will the metric system do to our proverbs and popular sayings? Imagine observing that "28.3495 grams of prevention are worth .4536 of a kilogram of cure," or that "a miss is as good as 1.6093 kilometers." Imagine a swain singing that he loves his girl "35.24 liters and 8.8 liters." Imagine Christopher Sly proclaiming in the opening scene of Taming of the Shrew that "I'll not budge 2.54 centimeters." It doesn't bear thinking about. ★

Keeping informed

Aluminum and magnesium — 36-page catalogue on Alcan aluminum, giving sizes, weights, alloys, etc. Designed for use with new edition of an aluminum and magnesium "select-o-chart" which shows the best alloy and temper for any given application. Alloy Metal Sales Ltd.

Circle 326 on Reader Service Card

Silicones—New 1960 edition of Engineering Guide to Silicones, containing 16 pages of product description for a range of applications from adhesives to water repellants for textiles. Dow Corning Silicones Ltd.

Circle 327 on Reader Service Card

Broaching tools—12-page catalogue describing broaches and broaching fixtures of all types, including those for finishing convex surfaces, cam surfaces and internal keyways. F. F. Barber Machinery Division.

Circle 328 on Reader Service Card

Thin ball bearings—New concepts for applying thin-sectioned large bore ball bearings to equipment designs are described in a 28-page engineering booklet. Kaydon Engineering Corp.

Circle 329 on Reader Service Card

Winding machines—40-page catalogue on winding machines and accessories for the electronics industry. Bayly Engineering Ltd.

Circle 330 on Reader Service Card

Air gauging—50-page booklet discussing many facets of dimensional control such as selection of the right amplification, when to use long-term air gauges, the principles of air gauging inside diameters, etc. Also lists the tooling and gauging fixtures used with column-type instruments. Sheffield Corp.

Circle 331 on Reader Service Card

Industrial tape—58-page pocket manual giving product data and applications for a complete line of pressure sensitive tapes. Includes a comparative listing for all tapes made in Canada, including competitive brands. Canadian Technical Tape Ltd.

Circle 332 on Reader Service Card

Relays and actuators—Leaflet describing a complete line for a variety of applications. Burlec Sales Ltd.

Circle 333 on Reader Service Card

Fluorescent ballast—16-page catalogue giving data tables, wiring diagrams, dimensions and specifications on a complete line of ballasts. Canadian General Electric Co. Ltd.

Circle 334 on Reader Service Card

Drafting template—Pocket-sized template to aid engineers, designers and draftsmen to draw cross metal retained seals. Available without charge. Parker Seal.

Circle 335 on Reader Service Card

Sludge collector — Design, installation and operating advantages of a new circular scraper sludge collector described in a 6-page bulletin. Chain Belt Co.

Circle 336 on Reader Service Card

Insulating resins — Guide to insulating resins, showing physical and other properties, characteristics, uses, etc. Marblette Corp.

Circle 337 on Reader Service Card

Industrial apparatus—A "quick selector" catalogue of motors, controls, industrial circuit breakers, safety switches, bus duct, panelboards, load centres, large air circuit breakers, dry type transformers and lighting. Canadian Westinghouse Co. Ltd.

Circle 338 on Reader Service Card

Cylinders — Folder containing full-size templets of a complete line of small size hydraulic and pneumatic cylinders. Accurate to the width of a pencil mark, the templets can be slipped under the tracing vellum and the designer can then trace the exact mounting style, bore and stroke he wants to use. Control Line Equipment.

Circle 339 on Reader Service Card

Fasteners—Catalogue and handbook of a complete line of cap screws, bolts, nuts, lock nuts, studs, etc., with prices, weights and technical data. H. Paulin & Co. Ltd.

Circle 340 on Reader Service Card

Ventilating and heating equipment—85-page catalogue on electrical heating, ventilating equipment, domestic refrigeration and electrical appliances. Canadian Armature Works Inc.

Circle 341 on Reader Service Card

RF bridge—Illustrated bulletin describes features, specifications, principle of operation, performance and applications of a multiratio bridge. The Glendon Co., Ltd.

Circle 342 on Reader Service Card

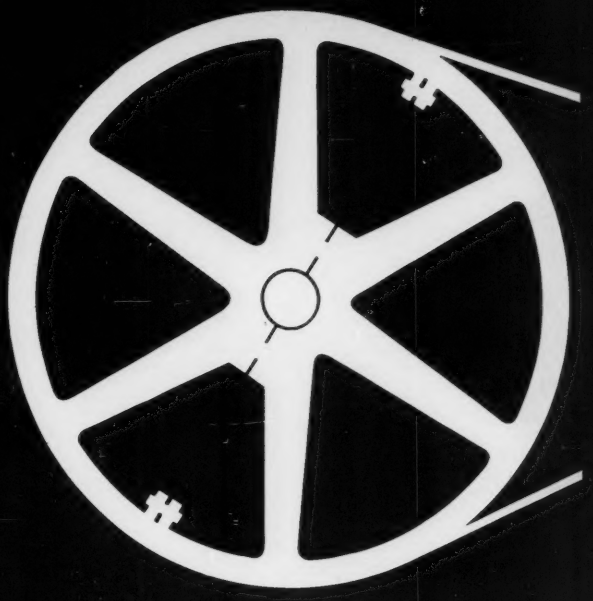
Penta prism—A 20-page illustrated booklet describes the behavior of Penta prisms. Engis Equipment Co.

Circle 343 on Reader Service Card

Sliding gate regulators—Three new bulletin sheets describe additions to this company's line of sliding gate regulators. Ontor Ltd.

Circle 344 on Reader Service Card

Design Engineering will feature Mechanical Power Transmission



in its issue of SEPTEMBER, 1960

There's no subject of more vital interest and concern to Canada's 6,700 design engineers than Mechanical Power Transmission.

The September issue of Design Engineering will be packed from cover to cover with practical, profitable, useful ideas on every phase of Mechanical Power Transmission — techniques, applications, new developments and new components.

Careful research — clear, explanatory writing — graphically-presented photographs, charts and formulas will make the September issue an exciting and valuable manual, to be carefully studied and kept as a permanent reference.

Timing your advertisement to run in the September issue will bring your products a direct source of extra business.

Design Engineering's audience knows that new ideas are the life-blood of good engineering design. In producing everything from giant railroad locomotives to tiny electronic computors — from automatic production equipment to domestic appliances, they search constantly for new ideas — new components — new finishes.

Arouse their interest and enthusiasm — create preference for your products — and your salesmen's call will close the order.

If you are a new advertiser, our one-time, one page, black-and-white rate is $308 — on a 6-time contract rate only $268 — and on a 12-time contract, only $235. Plan to feature your products in the important September issue.

an issue of particular interest and significance

RESERVE ADVERTISING SPACE NOW

FORMS CLOSE AT TORONTO AUG. 15th

Design Engineering

A Maclean-Hunter Publication 481 University Ave., Toronto 2, Ont.

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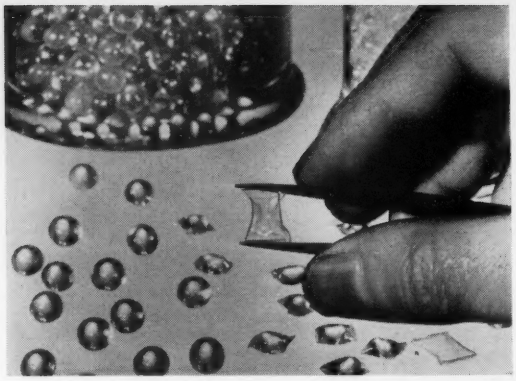
Ideas round-up

Many uses for balls of glass



Tiny balls or pillows of glass, both solid and hollow, are finding numerous applications in industry. For instance, hollow pillows provide a low density filler material in casting large plastic pieces. Solid ones are being used in chemical processing as fillers in refractionating columns and in filter beds. Glass balls are used in the anti-lint filters of automatic washing machines; they pick up the lint, which is then back-flushed, so that clogging is prevented.

These pillows and balls can be mass-produced in uniform shapes and sizes. Glass provides chemical stability and heat resistance and can be inexpensively formed. Source: Corning Glass Works.

Circle 345 on Reader Service Card

New polyethylene has household, auto applications

Designers at Canadian Thermos Products Ltd. had a plastic picnic jug on the drawing board for six years before they could get it into production. They had to wait until suitable polyethylene resins were available. A polyethylene of sufficient strength is now on the market and for the first time molded plastic picnic jugs are being made in Canada.

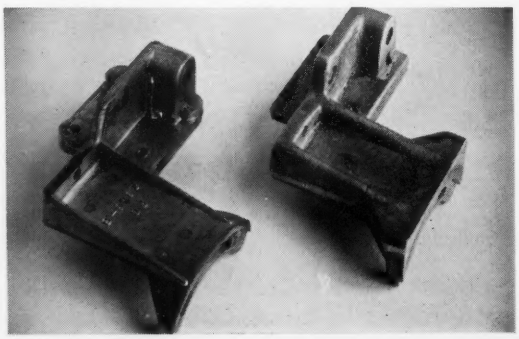
The jug is rustproof, unbreakable and 30% lighter than metal jugs. It requires 10 molds and a new assembly technique known as spin-welding, yet it's competitive in price. The linear polyethylene used in molding it is finding an increasing number of applications ranging from housewares to automobiles. It gives the end product rigidity, high boiling points, greater resistance to grease, and resistance to many chemicals. Source: Du Pont of Canada Ltd.

Circle 346 on Reader Service Card

Zinc gets the nod, aluminum out in mounting bracket

A commutator mounting bracket formerly made in aluminum has been converted to a zinc die casting. The changeover resulted in a production cost saving of 75%. The new design (left) costs $1 to produce, its sand-cast aluminum predecessor $4.

The company claims that zinc has greater tensile strength; the part is less bulky and metal is conserved because of thinner walls; machining is reduced; the die-cast part has a smoother surface. Aluminum sand casting required 21 machining operations; the zinc part requires only casting and trimming. Source: American Zinc Institute Inc.



Circle 347 on Reader Service Card

George Harry, *Assistant Editor*

U.S. engineers impressed by Canadian designs

This is what they liked at the New York show

Triodetic joints

Stereophonic earphones

Precision assembly diecasting

For the second year in succession, Canada showed some of her wares to a large audience of American designers in New York at the end of May. As as the 1959 Design Engineering Show in Philadelphia, the Canadian exhibit in New York's impressive Coliseum was a joint affair between private firms and the Department of Trade and Commerce.

This time there were 17 firms on exhibition compared with 29 in Philadelphia's Convention Hall. But if the quantity was lower everything else was much higher, including the location of the Canadian exhibit, the arrangement of booths, the literature supplied to enquirers, the products on display and the men and women who displayed them.

This last remark doesn't mean, of course, that the personnel at last year's show were of a lower standard. It refers to the fact that more booths were manned this year. Only one firm failed to send a representative, whereas more than half of last year's 29 exhibits stood unattended throughout the four days.

Magnificent location

The Canadian exhibit could hardly have been better located. It was on the second of the Coliseum's four floors, just to the left of the escalators. It could be seen from three aisles. It was only one corridor away from one of the most popular features of the show, miniature golf.

By and large, Canadian exhibitors were happy about the results. Three were exhibiting for the second time, having found the Philadelphia show worth while. It is probably safe to say that there will be more second and third-time exhibitors next year — if the Canadian Government sponsors another exhibit.

If it does, here is a suggestion: Take less space for yourself next time and give more space to your industrial exhibitors. Don't occupy a dominant position in the centre of the exhibit and crowd the design firms on the fringe, like a maternal old hen and her baby chicks. Remember, this is a design show, not an exhibit of government functions.

The foregoing suggestion doesn't ignore the fact that the government bears the major portion of the cost of the Canadian exhibit. Each of the 17 exhibitors paid a nominal $100 fee as its contribution toward the cost of floor space, leaving the Department of Trade and Commerce to finance the balance of over 80 percent.

How to reduce reluctance

Last year the exhibiting companies paid nothing and the department financed the entire cost. At that time Design Enginering suggested that firms should pay a nominal fee, if only to remind them that this is a promotion from which they can benefit, not a sufferance reluctantly undertaken at the Government's instigation. (The fact that 16 booths were unmanned suggested very reluctant participation.)

The obvious suggestion now is that the nominal fee should be slightly less nominal. More firms have now had time to assess benefits that flow from participation at the Design Show; they should now be willing to continue their participation on the basis of such benefits rather than because a generous government department is handing them the space. In return for this larger contribution, firms should receive larger exhibit space (or at least space more proportional with that occupied by the government department).

It might also be possible for firms to be offered booths of varying size. Those firms who have satisfied themselves about the show's benefits might want to take double space next time.

Assembly diecasting

Among those who were more than satisfied was Fisher Gauge Works Ltd., of Peterborough, Ont., whose exhibit was a precision assembly machine for small component parts using a die-casting method.

C. W. Fisher, the company's treasurer and production manager, was sought out by a visitor from Wilmington, Del., who had seen the Fisher exhibit last year. The man said that just recently he was faced with a problem and recalled that the Peterborough company could provide a solution.

"This is rather typical," said Mr. Fisher. "People visit the show to see

Continued on page 91

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Cowan Dynamics Cylinders are manufactured under the strictest quality controls and thoroughly tested before shipment for absolute compliance with our high standard of performance. Consequently, Cowan Dynamics Cylinders are extremely dependable and deliver superb performance year after year.

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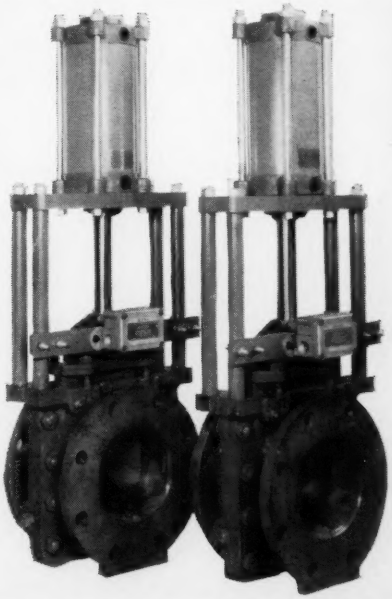

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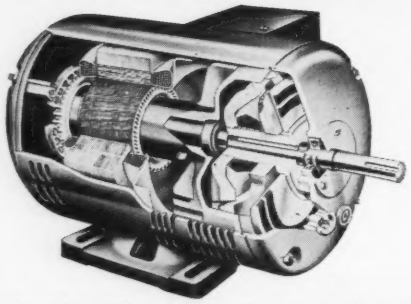
AJUSTO-SPEDE DRIVES



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Under constant torque or fan type load, the Ajusto-Spede may be operated continuously at any speed within the limits of the speed range. Electronic control insures speed stability of plus or minus 2 per cent of top speed at any point within the range.

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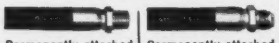

Permanently attached Male. (NPTF) for 1, 2, & 3 wire braid hose—also 4 spiral wire.

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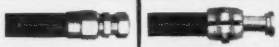

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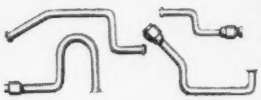

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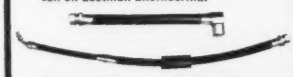

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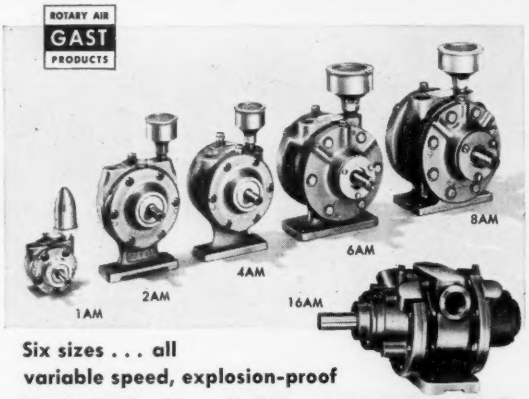

Six sizes . . . all variable speed, explosion-proof

GAST rotary AIR MOTORS

Need compact, low cost power? For plant use and original equipment applications, Gast rotary-vane Air Motors offer these distinct advantages:

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2. Low initial cost per rated h.p.
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5. Vanes take up their own wear.
6. Reversible rotation (opt.) 5 sizes.
7. Very compact — light in weight.
8. Top-quality ball-bearing design.

TYPICAL PERFORMANCE

Model No.	H.P. at 90 PSI 2000 RPM	Weight lbs.
1AM	0.13	1⅓
2AM	0.57	5½
4AM	1.1	8
6AM	2.0	17
8AM	4.0	25
16AM	7.0	65

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• VACUUM PUMPS TO 28 IN.
"Air may be your answer!"

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Canadian designs impress

Continued from page 88

what needs it can provide. Sometimes they have no need for a particular thing, but the need develops later."

Triodetic joints

Equally satisfied was Arthur E. Fentiman of F. Fentiman & Sons Ltd., whose exhibit of Triodetic joints and connectors was singled out by the "New York Times" for headline mention. The Times said:

"The Canadian Government exhibit included a new construction material made of aluminum tubing. The tubing can be assembled by inserting the tube ends into a slotted hub without bolting, rivetting or welding. It can be used to assemble the frames of buildings or to make furniture, docks for boats or other structures."

Mr. Fentiman said many people came specially to look at the triodetic exhibit after reading about it.

A comment heard among some visitors was that the Fentiman display was the only one in the 225-ft. long Canadian exhibit which had true design interest. But if this is a valid comment, it's equally true that the Design Show as a whole didn't have

Continued on page 92

New products at the Design Show

Photosensitive glass and glass-ceramics have been developed which can be accurately patterned at low cost by simple art work. Applications for these materials include printed circuit board, fine mesh screens and dielectric spacers.

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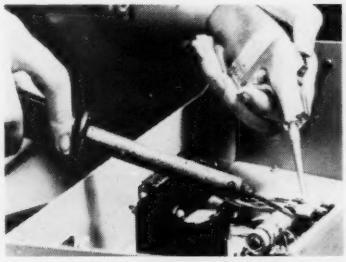

Wire soldering problems are solved by a dispenser whose push button feeder adjusts the right amount of solder for each application. The dispenser comes with various attachments, including straight or curved probes in several lengths for hard-to-get-at areas. It feeds solder wire from .028 in. to .074 in. diameter.

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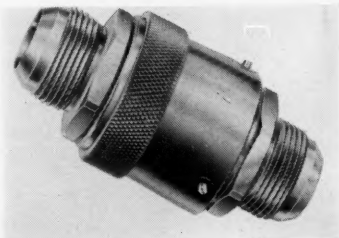

This self-sealing coupling is specially designed to provide fast, safe connections in applications where foolproof locking is mandatory. Hence there is no stable, partially connected position permitting fluid to flow. The coupling will connect or disconnect with a one-hand movement, but will not disconnect accidentally.

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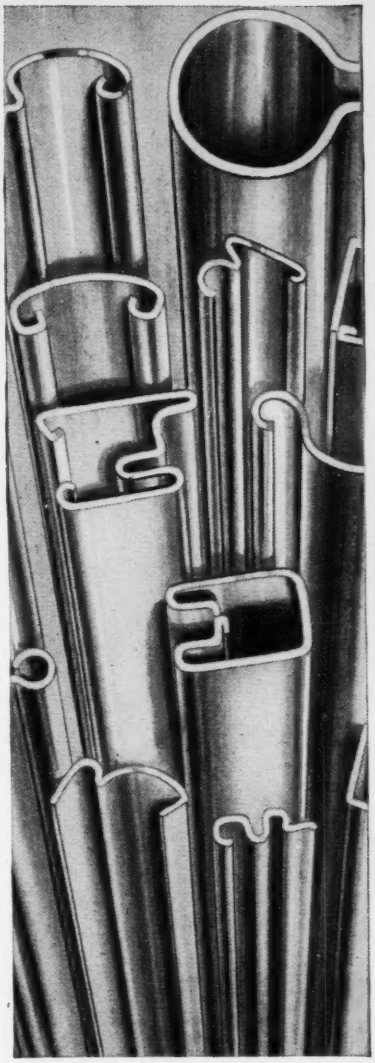
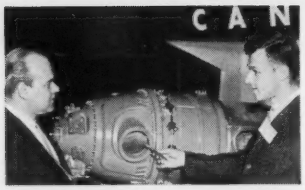
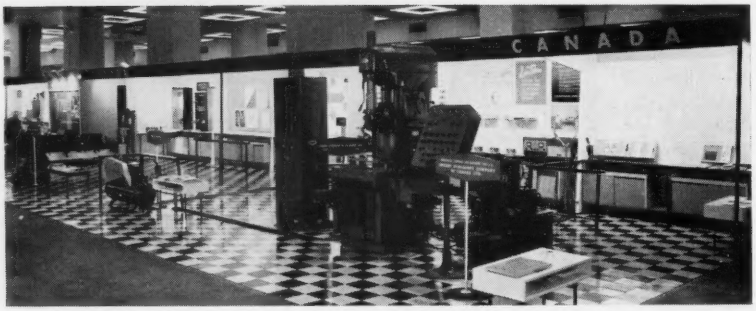




This cut in the "New York Times" (see text) aroused comment among Canadian exhibitors It shows two government officials studying a Pratt & Whitney engine.

Design Engineering's booth



A view of the Canadian exhibit at the Design Engineering Show

Canadian designs impress U. S. engineers

Continued from page 91

too much to offer the designer as such. Much of it was concerned with materials, much of it was aimed at the purchasing agent. To quote the Times again:

"The exhibits were designed to show that metals do the job better than plastics, or plastics better than metals, or glass better than both."

Dearth of experts

Another criticism of the show generally was that many booths were manned by personnel not qualified to answer serious questions of design interest. Many visitors said they received vague or silly answers, and not only from booths where the attendants were pulchritudinous.

On the subject of pretty girls, J. R. Johnson, manager of Canadian Patents & Developments Ltd., said that in his experience the serious visitor shunned booths which went in for this type of gimmick. They felt there was nothing to be learned at such booths.

Mr. Johnson's comment on the Canadian exhibit was that while it drew crowds, they hovered on the fringe and didn't step to the back, where his own booth stood. (It was a peculiarity of the Canadian exhibit that 11 exhibitors occupied space at the back and six in the front.)

"We were too far from the aisle," said Mr. Johnson. "People took a quick look and if there wasn't an attention-stopper they moved on."

The double-deck arrangement of the Canadian exhibit, while it might not have been popular with the firms at the back, certainly benefitted those in the foreground, all of whom showed large or fairly large exhibits, such as Fentiman's triodetic joints or Fishers' precision assembly machine.

Stereophonic earphones

Other exhibitors complained of being hidden by machinery in the foreground, but at least one overcame the handicap. Sharpe Instruments Ltd.'s booth was crowded on all four days of the show. What attracted the crowds was not the unique design features of the company's Live-Tone earphones, but the truly beautiful sound reproduction they gave. The two company officials who manned the booth, Val Burden and Mrs. Ruth Parker, estimated the number of enquiries at 500 to 600 the first day and 800 to 1,000 on each succeeding day.

However, they were not happy about being overshadowed by a large automatic positioning machine and asked to be moved to the adjoining booth, which happened to be on the corner. This booth was occupied by the Government of Canada (as distinct from the Department of Trade and Commerce, which occupied the centre of the exhibit). The Government of Canada (whose booth hardly attracted a visitor) refused to move or swap places.

Incidentally, though the Sharpe Instrument Ltd. exhibit had intense interest for the design engineer, its market is of course much larger, and the company will probably do well to exhibit at exhibitions with a wider public appeal. The public were not admitted to the Design Show; the 20,000 visitors were all designers, other engineers, buyers and others in the trade.

Another firm that was happy about the show was Measurement Engineering Ltd., which showed a dynamic ground detector and a brightness meter. D. A. Bamford, the company's general manager, said that though they had not come to the Show to attract attention, they were pleased at the attention they attracted. Their chief purpose, he said, was to negotiate a U. S. representative.

Mr. Bamford felt that the Department of Trade and Commerce had done a good job, but his views were not shared by the majority of exhibitors. Apart from the criticisms already mentioned (that large machinery displays shouldn't have overshadowed other exhibits and that the Government held too much space) another was that the department had lacked judgment in grouping several static exhibits together, with the result that a large area of the Canadian exhibit drew little attention from the passing throng. (Some exhibits consisted of

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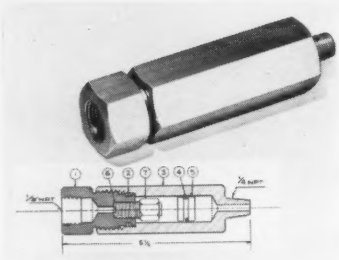
New products at the Design Show



This flow check snubber protects plant personnel against noxious, toxic or flammable liquids or gases in the event of pressure instrument failure. It does this by isolating instruments from the pressure-actuating medium.

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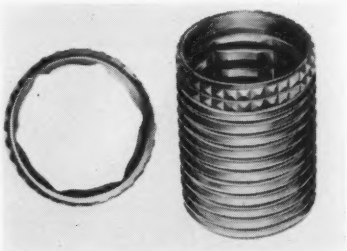

This revolutionary insert has an internal thread lock which will positively secure the engaging bolt or screw, even after countless insertions or removals. The fastener has universal application and is suitable both for original design or replacement for wire-type inserts.

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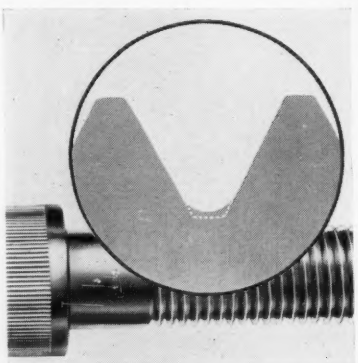


A new thread form can double fastener fatigue life under dynamic loading. The principal change is the smoothly radiused root; this greatly reduces failure-producing stress concentrations in a section of a tension screw (the least cross-section of the thread) where an estimated 85% of fatigue breaks occur.

Circle 353 on Reader Service Card

Canadian designs impress

Continued from page 92

nothing more stimulating than a few photographs.)

Replying to this criticism, a government official said they had planned to alternate static and live exhibits, but were foiled by a series of mishaps. For instance, the Ontario Research Foundation had planned to show a model railway illustrating impact-induced stresses, track vibrations and other features.

At the last minute they found that the railway could not be finished in time. They then decided to substitute a model of a steel furnace; but the customer for whom it was built wouldn't let it be exhibited. It was then too late to provide any live display, so they had to be content with pictures and signs.

The government official said that Canadian Patents also had an interesting novelty to display, but unfortunately it failed to arrive in time, so they too had to use pictures.

Publicity shortcomings

A smaller criticism was that the government men seemed to be singularly unimaginative in their handling

Canadian designs impress

Continued from page 94

of publicity. The Design Show's press room was crowded with U. S. literature, releases, pictures, and so on, but the only contribution from Canada was a booklet of 40 pages listing the exhibits. Some critics felt that a few press releases would have been more easily assimilated than a booklet, would be more in keeping with the general range of press material, and would permit the dissemination of late news.

Another criticism of government officials was that some were rather publicity-conscious when the press photographers happened along. For example, a picture of a Canadian Pratt & Whitney aircraft engine was published in the "New York Times." To give the photograph some animation, the photographer asked for two men so that one could be demonstrating to the other. The two men in the picture were both government officials.

"Wouldn't it have been better," asked one critic, "if a Canadian Pratt & Whitney man could have been photographed showing the engine to a potential customer?" Told that no customer was available when the photographer called, he said his argument was still valid. (Other pictures of Canadian exhibits published in the New York papers also showed one government man demonstrating a product to another.

Why were tapes stolen?

The final criticism revolves around a misfortune suffered by the most popular of Canada's exhibits at the Design Show. On the first night of the show four recording tapes were stolen from the booth of Sharpe Instruments Ltd. The tapes were only valued at $35 and the loss was not irreparable, but it might have been disastrous if earphones had been stolen.

The loss of the tapes raised the question: Why were these valuable articles not locked for safekeeping in the Department of Trade's lock-up cupboard behind its exhibit?

Answer: Because the department's staff failed to build a back wall for the cupboard!

The technical sessions

Technical sessions on the four show days were sponsored by the ASME, with national and local groups cooperating in the effort. The subjects covered (see Design Engineering, May issue) ranged all the way from a panel discussion on "New Horizons in Design Engineering" to a lecture on "Reliability."

Possibly the most common comment heard about the technical sessions was that the speakers were too far removed from the actual design function. As one engineer listener said, "It's no good to ask the top brass to give these speeches. They only have to ask the little Joe to ghost-write them anyway." This fact was never more evident than in the question periods which comprised part of each session. To hear a speaker plead lack of knowledge on a subject which he had mentioned in the formal part of his speech was most disturbing.

The sessions were well attended, and there appeared to be something of value for every engineer there, no matter what his level of responsibility or area of technical interest. And the audience participation was excellent—in all sessions we attended the experts were unable to complete the list of queries submitted for them to answer. One final suggestion—could possibly one Canadian be asked to participate next year?

Designers' book shelf

Engineering Manufacturing Methods, by Gilbert S. Schaller, Professor of Mechanical Engineering, University of Washington. Publisher—McGraw-Hill, Toronto. 680 pages. Price $9.20.

One of the most practical books your editor has had the privilege to read. Manufacturing methods are correlated with engineering design and materials. All phases of engineering manufacturing are covered. Contains over 450 illustrations.

The author has included discussion on such vital manufacturing processes as casting, forming, machining, grinding, welding and finishing. When you, as a design engineer, want to compare one or more manufacturing methods, this book will be a useful reference.

Circle 354 on Reader Service Card

Mechanics of Materials, by Higdon, Ohlsen and Stiles. Publisher—John Wiley and Sons, New York. 500 pages. Price $7.75.

Although essentially traditional in its organization, this book features ideas which are compatible with modern engineering practice. The authors emphasize the use of free-body diagrams and the equations of equilibrium. A large selection of examples is included, with special attention paid to problems that require an understanding of the principles of mechanics of materials without demanding excessive time for computational work.

Circle 355 on Reader Service Card

Malleable Iron Castings—prepared by the Malleable Founders Society. Publisher Ann Arbor Press, Michigan. 530 pages. Price $10.

This book represents a truly comprehensive treatment of the subject of malleable iron, with judicious balance between all aspects of special interest to a wide variety of potential readers. Since machinability is one of malleable's characteristics, this subject is covered in detail. Included in the machining chapters are discussions of all basic operations — turning, drilling, boring, milling, and tapping. The book has been written among other things to aid the designer in his work on metal components.

Circle 356 on Reader Service Card

Basic Electronics, by Bernard Grob, Instructor, RCA Institute. Publisher — McGraw-Hill, Toronto. 524 pages. Price $9.25.

A complete guide covering all the fundamentals for successful work in electronic circuits. Includes AM, FM, TV, and industrial applications. For each topic covered examples are given that show how principles are applied to actual conditions — including techniques for trouble-shooting.

Only a minimum amount of mathematics is used (we loved that feature!) and the text is simply written. An excellent book for all levels of engineers.

Circle 357 on Reader Service Card

Other recent engineering publications: Mathematical Methods for Digital Computers, by Ralston and Wilf. Publisher—John Wiley, New York. 300 pages. Price $9.

Circle 358 on Reader Service Card

Mathematics of Science and Engineering, by P. Alger, Consulting Engineer, General Electric Company. Publisher — McGraw-Hill. 360 pages. Price $7.75.

Circle 359 on Reader Service Card

Plant Engineering Handbook, by Staff of Specialists under W. Staniar. Publisher — McGraw-Hill. 2,400 pages. Price $27.50.

Circle 360 on Reader Service Card

backlash

An introduction

That design is always changing is a theme often featured in this publication. Regular readers know that we practise what we preach, for many design changes have taken place within DE itself.

For instance, new departments have been added, including "Designer's book shelf" and "Designews". In other departments minor revisions have been made in style and presentation. Major changes have been made in the presentation of feature articles. Also we have been giving greater emphasis to the Canadian aspect of design engineering; the preview in May of Design Engineering Show was along this line.

A further example of this Canadianism is the feature "Designews in Pictures". In the past this has been a composite of the most interesting pictures we could get, regardless of source. Some months they all came from south of the border. Last month we introduced a different "Designews in Pictures": a completely Canadian picture story of the National Industrial Design Council's exhibition, Design in Retrospect. In the coming months we plan to show the best of other Canadian designs if we can pry the details from the Canadian companies.

Another of our new departments is the one you're now reading — Backlash. Our dictionary defines "backlash" as the "jarring reaction of a machine or mechanical device." That sums up this new department. If we can influence a few designers for the better, if we can jar the inactive into action, then Backlash will have accomplished its purpose.

We don't need to remind you that your comments on the new features, and on any other aspect of this publication, will always be welcome.

Contest comments

In the April issue DE announced a contest — open to all readers — to write 300 words or less on any subject dealing with fluid power. Cash prizes to the best entries were to total $200.

The results of the contest were disappointing, to say the least. A grand total of three entries were received, and not all of the three stuck to the appointed subjects. Because of the poor response the contest has had to be withdrawn.

However, DE has forwarded cheques for twenty-five dollars to each of the three entrants:
T. Baxter, Leland Electric, Guelph, Ont.
F. R. Cracknell, DeHavilland Aircraft, Toronto
E. Wharton, Scarborough, Ont.

We have tried to understand the situation as reflected by this experience. Could it be that engineers are too well paid in Canada? That $100 for fifteen minutes effort was not enticing enough?

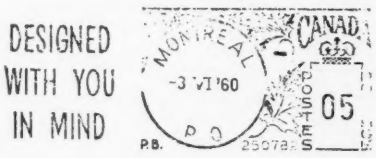
Could it be that engineers in Canada are so inarticulate that they cannot write 300 words on an engineering subject? Judging from some of the meetings we have attended that could well be the case.

That this failing is not peculiar to engineers was apparent at the Design Workshop held in June under the NIDC sponsorship. All three sessions of the workshop gravitated to one common denominator. This was the failure, or inability, of the industrial designer to communicate with those who were his associates in industry (look for a full report next month).

Finally — and we hesitate to mention this — could it be that Canadian engineers are just too lazy to put forth the effort, whether it be physical or mental, to create something original? Have we too long leaned on our American and British counterparts for our reading material — and our ideas?

We really don't know — we are still looking for the answer.

Mail sale



This interesting postal slogan is used by Radionics Ltd., Montreal, on all its mail. The company's president, Stanley H. Ungar, tells us that he selected it from a long list of meter slogans because it typifies their services. "Our product lines are designed to meet the requirements of research and development groups," he explains. "They are in fact engineered, human-engineered, specially for the customer."

Mr. Ungar feels that the slogan has become identified in the customer's mind with Radionics' unique combination of product lines. The same slogan is currently being used in the company's advertisements.

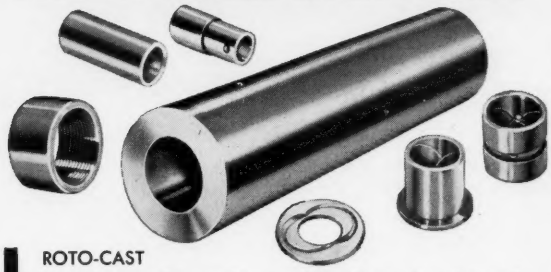
Avro aftermath

Canada's hopes of building the world's fastest plane came to an inglorious end when the Avro Arrow was dropped. Just recently the Arrow's scrap metal was sold for just over $300,000, which is .006 percent of the $500,000,000 which had been spent on the project.

A further irony is that our industrial competitors are now benefiting from the experience of many of the engineers who trained on this project — at the country's expense.

FOR QUALITY AND ECONOMY IN PRODUCTION ROTO-CAST

Centrifugal Bronze Bars or Precision Finished Bronze Bushings



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The high quality castings resulting from the advanced ROTO-CAST process offers Industry a bronze bar as perfect as metal can be—no hard spots, no sand or gas inclusion, no shrinkage cracks—dense, fine-grain structure throughout. Cut scrap loss 15% to 50%—40% to 60% longer wear.

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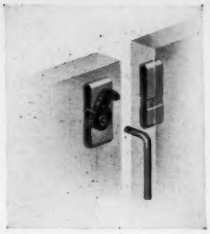

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Editorial

Fluid power industry needs to wake up

. . . the competition is tough — it knows where it's going

We know of no other engineering industry in Canada that needs to look more to its policies and practices than the industry featured in this month's issue — fluid power. We are convinced that a thorough self-examination is called for — a standardization program is required — and a long range educational program would pay untold benefit.

Most of those associated with the industry are fully aware of the situation, and we have discussed it personally with many of them. One engineer, for instance, told us that whenever he has a problem involving fluid power he gets the application experts from the supply companies to submit design proposals. Then he reviews the proposals, eliminating the unwanted and unnecessary features and components. "Usually," he says, "we are able to cut out about half the stuff suggested, with a corresponding cut in costs." Fortunately this man is an expert in fluid power and he knows what he is doing. Others, not so well informed would either have to accept the original proposal at an unduly high cost, or else look for an alternative.

We hesitate to even mention the standards problems, they are so widespread. Mr. D. Guy, P.Eng. (see page 52), addressing a meeting of the Standards Engineers Society in Toronto, admitted that there was little or no standardization effort in the fluid power industry. "Even the nomenclature differs between pneumatics and hydraulics," he said.

Yes, there are standard JIC drafting symbols. But let's read again what I. Walle says on page 46 about some of them.

The symbol rarely bears any physical resemblance to the valve it represents and a circuit diagram becomes a rather fearsome array of lines and boxes, completely understood only by those familiar with the symbols.

All fluid power systems are pressure systems. Some operate at pressures in the thousands of pounds. Yet, to our knowledge, the components and designs are not required to meet any safety code, nor to receive any official government inspection, as in the case of other pressure vessels. We suggest that the provincial departments of labor should investigate this situation soon.

Educationally the fluid power industry is way behind most of its contemporaries. For instance, we have deliberately made all of the articles in this special issue as basic as possible, at the request of many of our readers. The knowledge of most engineers on fluid power and its possibilities is on a very low level indeed.

A few companies, notably Vickers-Sperry (working with Ryerson Institute in Toronto) have made some effort to educate interested engineers on the subject. The ASTE in Montreal sponsored a most successful night course last winter in collaboration with one of the educational groups in that city.

But such individual efforts are not enough. The only true solution to this problem, and all the other problems plaguing the fluid power industry in Canada, is to be found in a co-operative effort by everyone in the industry. And we do mean everyone.

Doug Kaill

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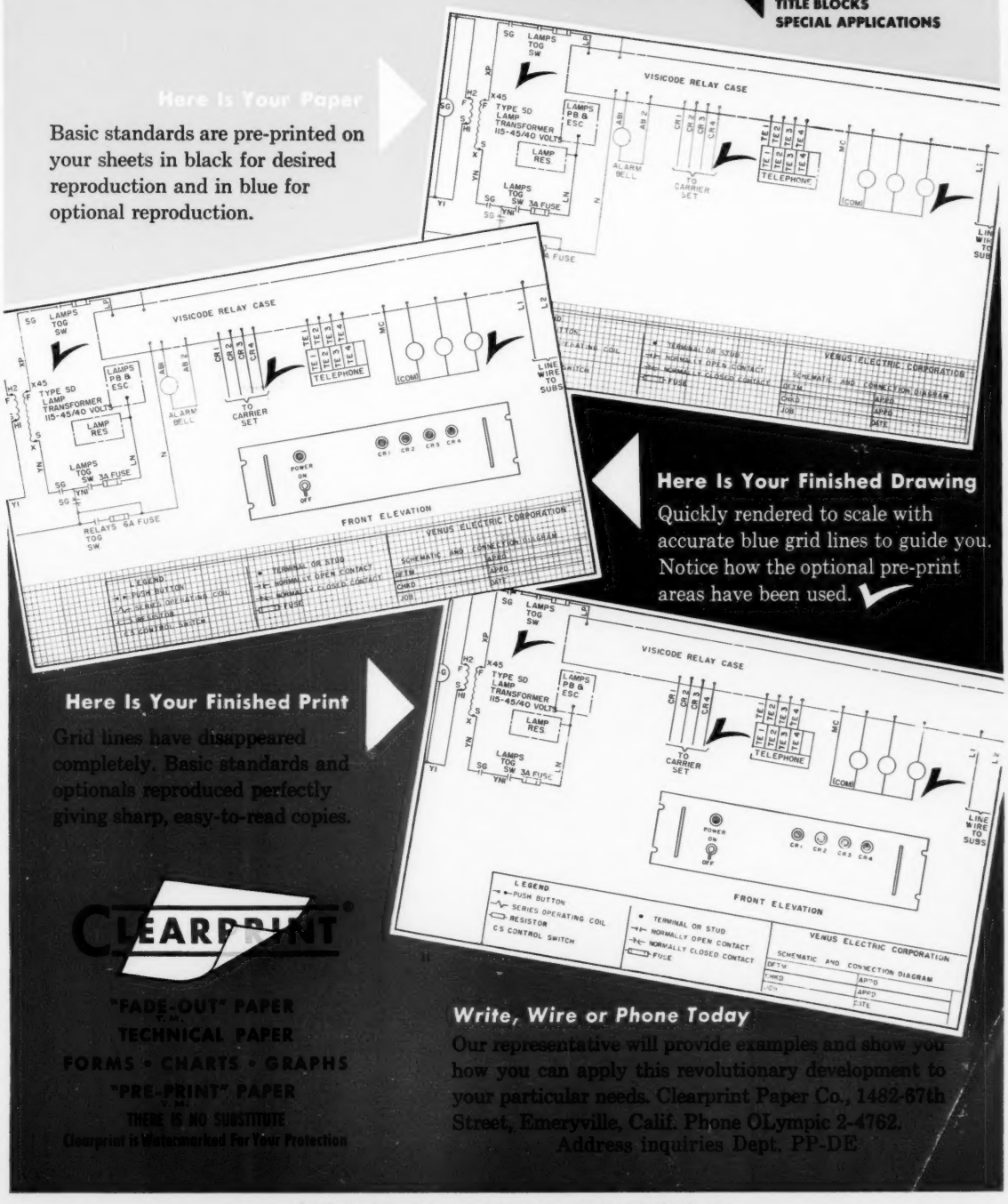

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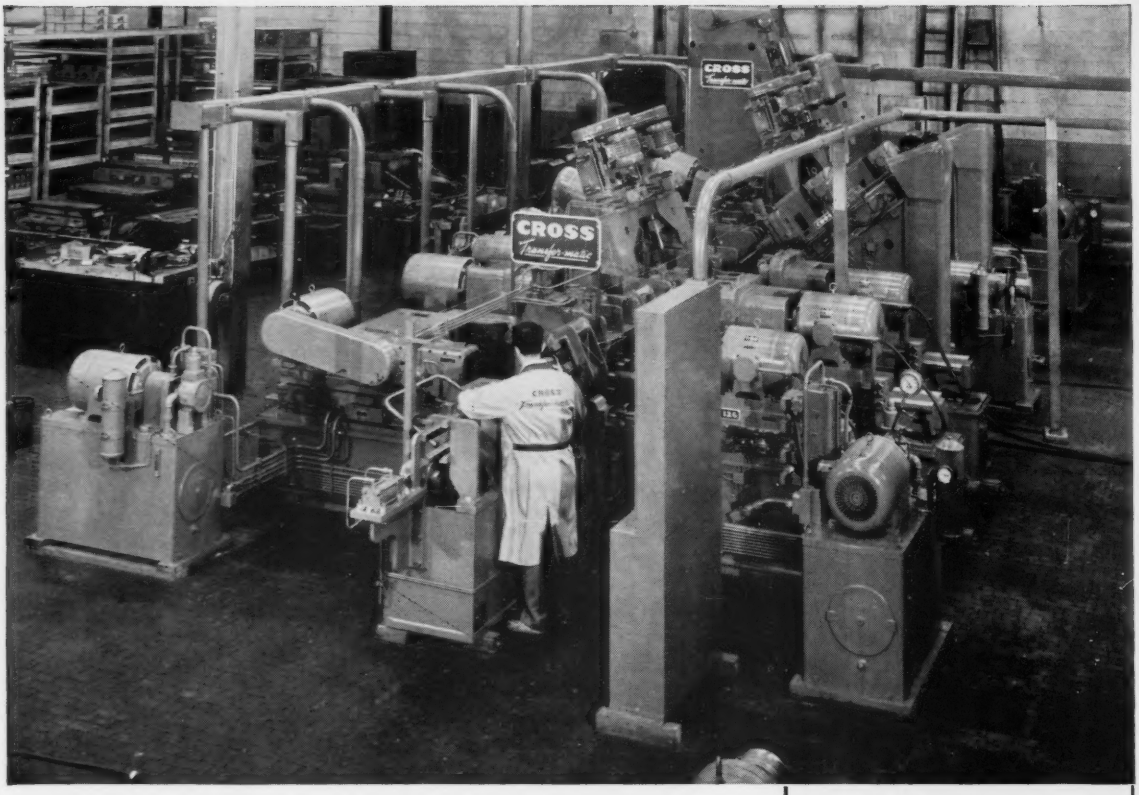

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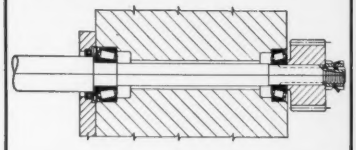

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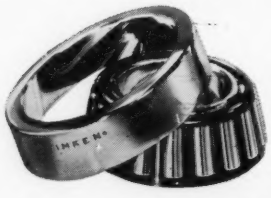

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